CHARLETON

PHYSIOLOGIA

1654

PHYSIOLOGIA
Epicuro-Gaſſendo-Charltoniana:
OR
A FABRICK
OF
SCIENCE NATURAL,
Upon the Hypotheſis of
ATOMS,

Founded, Repaired, Augmented by *EPICVRVS*, *PETRVS GASSENDVS*, *WALTER CHARLETON*,

Dr. in Medicine, and Phyſician to the late *CHARLES*, Monarch of Great-*Britain*.

The FIRST PART.

Fernelius, in præfat. ad lib. 2. de Abditis rerum Cauſſis.

Atomos veteres jam ridemus, miramúrq; ut ſibi quiſquam perſuaſerit, Corpora quædam ſolida, atque individua, fortuita illa concurſione, res magnitudine immenſas, varietate multitudinéq; infinitas, omnemq; abſolutiſsimum hunc Mundi ornatum effeciſſe. At certè, ſi Democritus mortem cum vita commutare poſſet, multò acrius hæc, quæ putamus Elementa, ſuo more rideret.

LONDON,
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1654.

TO THE

HONOURABLE

Mris. ELIZABETH VILLIERS,

WIFE

TO THE HONORABLE

ROBERT VILLIERS

ESQUIRE.

MADAM,

He excellent Monſieur Des Cartes, *I remember, in his Dedicatory Epiſtle of his Principles of Philoſophy, to that illuſtrious Lady, the Princeſs* Elizabeth; *ſhewed Himſelf ſo much a Courtier, as to profeſs unto Her Highneſs, that of all Perſons living, who had peruſed his former Writings, He knew none, that perfectly underſtood them, except Herſelf only. This, Madam, is ſomewhat more than*

what I ſhall adventure to ſay to you, in this my humble Addreſs. Not that I might not, with the Authority of Truth, and the willing Teſtimonies of all judicious Perſons, whom you have at any time dignified with your incomparable Converſation, affirme; That Acuteneſs of Wit, and Soundneſs of Judgement are as Eminent in you, as in any that I know, of either Sex. *But, that I conceive it to be more conſiſtent with my Duty of Conformity to the ſtrict Laws of your Humility (which is ſupreme among your many Virtues, if there can be Supremacy where All are Superlative) only to ask you leave, ſo far to juſtifie My ſelf, in this way of Devotion, as publikely to own my Aſſurance; that of all my Readers, none will meet with fewer Difficulties, or diſcover more Lapſes and Errors, than your ſelf: nor could that Book be clearly underſtood by the Author, when He wrote it, which you cannot eaſily underſtand, when you are pleaſed to read it; be the Argument thereof of what kind ſoever, and the Language either* Italian, French, *or* Engliſh, *which are all equally your own.*

But, I have little reaſon to ſpeak of juſtifying *this my Devotion, to the World; when that, by the General Tribute of Admiration and Reverence, which your Excellencies duely receive from it, is fully convinced, that I am not capable of declaring a greater Prudence, in any action of my whole life, than in this of laying down both my ſelf and this mean Oblation of my Obſervance and Gratitude, at the feet of a Perſonage, whoſe ſingle Name is acknowledged to define All the poſſible Perfections of Humanity: and, upon conſequence, cannot fail to give to both Me and my Writings not on-*

ly

ly an Estimation among Good Men; but also a full Protection from the Malevolence of Evil. And, I have been very lately told by some (and Those such Eminent Witts too; as that very Noble Persons, to whom they have Dedicated their Labours, have thereby received no small Additions of Honour) that they seriously Envied the good fortune of my resolution of invocating your Patronage of this Epicurean Philosophy; forasmuch as they were confirmed, that I had taken the most certain course, to procure Immortality thereunto, by offering it up to the Favour of so great an Example of all Heroick Accomplishments, as that Her Memory must ever continue verdant and sacred to all Posterity: since it could not be, while Generous Minds should conserve the Memorials of Her as the Mirrour in which Vertue used to dresse Herself, when she would appear Amiable and Graceful; but that they must often cast some glances of valew upon the Remains of Him, who had so deep a sentiment of Her goodness, as to have known no other Ambition, but that commendable one of making Himself eternally known for Her most humble and obsequious Votary.

That, which would more become me, were to make my Excuses *for the exceeding Boldness of this my Application; and to prevent such* Objections *as may lye against the Rashness of my Zeal: in selecting such a way to express my Reverence, as cannot secure me from a suspect of Prophanation; and præsenting to you such a Sacrifice of my Thankfulness, as, if estimated according to its own Unworthiness, must make it a quæstion, whether I had any designe of being Thankful at all. And here, to the* First, *I might justly plead; that a great Part of*

this

this Volume was compoſed in your Houſe (the chief Manſion of well-order'd Hoſpitality) and All of it in the ſtrength of your Inſpiration. That the Book comes not into your hands, to Informe, but only Remember you of many of thoſe Diſcourſes of Nature, which your Noble Husband and your ſelf have often ſuffered me to entertain (would to God, I might have ſaid, ſatisfy) your eager Curioſity withal, at thoſe hours your induſtrious Minds required Relaxation from the bent of more grave and advantageous Thoughts. That, having the Honour of ſo great a Truſt, as that of your moſt præcious Lives committed unto me; it highly concern'd me, to ſtudy and purſue all ways of Demonſtrating my ſelf not altogether uncapable thereof, and more eſpecially this of Natural Philoſophy, which being the Grounds, is alſo the Meaſure of a Good Phyſician. And, that when your Husband being acquainted with my Purpoſe of Enquiring into the Nature of Souls, both Brutal and Human, in a diſtinct Work, though but the Remaining Moity of this Phyſiologie; had injoyned me to deliver the ſame into his hands, as ſoon as I ſhould have finiſhed it: I inſtantly apprehended, I had an opportunity of a Double Happineſs, the one of being equally Grateful to Two ſingular Friends; the other, of Allying thoſe Two Treatiſes by Conſecration, which would be of ſo neer Affinity in their Subjects.

As for the Other; *I might eaſily alleage, that Great ſpirits uſe not to eſtimate Præſents that are brought them, by the value they carry in themſelves: but the Affections of thoſe who offer them. That Thankfulneſs is the Poor mans wealth, and makes him, in the eyes of Generoſity, ſtand in competition, for reſpect, with the Rich. That though this my Oblation hold no proportion to the im-*

immenſe height of your Merit, yet it is equal to that of my Power, and, indeed, the beſt that my Gratitude was able to advance upon the ſlender ſtock of my Capacity. And, that I never intended it as a Retribution for your incompenſable Favours; but only as an Homage, to teſtifie that I confeſs my ſelf infinitely your Debtor.

But, Madam, for me to attempt to Excuſe, unto your ſelf, the Unfitneſſe of this Act of my devotion; is no leſſe unneceſſary, than for me to juſtifie to the World, that I have placed it upon a moſt worthy Object: foraſmuch as I have no more reaſon to doubt, that ſo tranſcendent a Charity, as is diffuſed through and ſurrounds your perfect Soul, can be large enough to diſpenſe with the Rudeneſs of the Ceremonies, and Poverty of the Offering, where you are ſatisfied of the ſincere Reſpects, and unalterable Fidelity of his Heart, who tenders it; than I have to fear, that the World ſhould not moſt readily confirm my judgement, that your Deſerts have rightfully entitled you to all the Demonſtrations of Honour and Reverence, that can poſsibly be given to you.

The Chief part, therefore, yea the whole of my preſent Duty, is only humbly to Beg your benigne Acceptance of this Dedication, as the Beſt Expreſſion I was able to make of thoſe profound ſentiments which as well your Goodneſs in General to others, as your Particular Favours to my ſelf, have impreſſed upon my Soul. And this I now do, upon the Knees of my Heart; and ſolemnly vow, that as I eſteem a perfect Friend, the greateſt Treaſure of my life, ſo I do and ever ſhall account you the moſt perfect of Friends: That I ſhall confeſs my ſelf to have loſt not only all Piety, but all

Hu-

Humanity alſo, when ever I ſhall willingly loſe any the leaſt opportunity of ſerving you: and that your own Good Angell (I ſpeak familiarly, but at the ſame time believe you to be under the Tuition of a Legion of Good ones) cannot more fervently deſire your complete Happineſs, than, Incomparable Madam,

Your Eternal Servant,

London the 20 of *July*,
An. Dom. 1654.

W. CHARLETON.

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READER.

THe Authors frequent Absence from the Towne, during this Impression; and the Division of the Copy among several Compositers, who could not all be Equally acquainted with His Hand; together with the multiplicity of Affaires, that diverted the Master Printer from the full discharge of his undertaking in the Correction of each sheet, before it was wrought off: have unhappily occasioned many Errata's *in this Book. Of which such as consist only in the Misplacing, Duplication, Inversion, Omission, of Letters; or in the wrong position or Omission of Points, and other Pauses; these may be more easily Excused, than collected into a Catalogue. But, as for those less Venial ones, that seem either to trouble or invert the sense; or render the Authors care in Orthography suspected: you may please to Correct them (so many of them, at least, as the Author observed in once reading over the Book) thus.*

In the *EPISTLE.*

Page, 3: line 18. read value, for valew.

In the *TABLE.*

PAg. 2. col. 1. line 18. read Essence of Place. col. 2. l. 14. r. Vacuola, or Empty spaces. & l. 23. r. in equal quantity, suspected. &. l. 42. r. Inventor. p. 4. col. 2. l. 5. r. whether. & l. 10. r. Dimensions, & l. 16, r. Des Cartes. &. l. 31. r. Dimensions. p. 5. col. 1. l. 5, r. generally distinguished: & col. 2. l. 44. omitt the: & l, 45. r. cannot run on &c. Page. 6. col, 1, l, 23. r, dissentaneous to Reason, & l, ult. omitt the. col, 2. l, 3. r. Democritus & l, 12, r. compound Nature; &. l. 25, r, mathematicall, Page 8, col. 1. l, 2, r. things: & l. 30. r, Accension. col. 2. l. 24. quantity of &c. P. 9. col. 1, l. 38, & 39: r, Des Cartes, p. 10, col, 1. l. 10. r, poreblind; p 13, col, 1, l. 30, r. a symbolisme betwixt the &c: & col. 2. l. 38. in their several relations. p. 18, col. 1. l. 22, r. syzygia or &c. p. 21. col, 1. l, 32, r. the principal Authors of each.

BOOK the FIRST.

CHAP. I.

All Modern Philosophers reduced to four general Orders; and the principal causes of their Dissention.

SECT. I.

IF we look back into the Monuments or Remains of *Antiquitie*, we shall observe as many several SECTS of *Philosophers*, as were the Olympiads in which *Greece* wore the Imperial Diadem of *Letters*; nay, perhaps, as many as she contained *Academies*, and publike *Professors* of Arts and Sciences: Each Master affecting to be reputed the principal Secretary of Nature; and his Disciples (their minds being deeply imbued with his principles) admiring him as the Grand Oracle of Divinitie, and the infallible Dictator of Scientifical Maxims. The chiefest, most diffused, and most memorable of these Sects, were the *Pythagorean*, the *Stoick*, the *Platonist*, the *Academick*, the *Peripatetick*, the *Epicurean*, and what, derided all the rest, the *Pyrrhonian*, or *Sceptick*; which feircely contended for the Laurel, by subtle disputations on the side of absolute Ignorance, and aspired to the Monarchy of Wisdom, by detecting the vanitie and incertitude of all Natural Science. As for the *Megarick*, *Eretrick*, *Cyreniack*, *Annicerian*, *Theodorian*, *Cynick*, *Eliack*, *Dialectick*, and others less famous; *Diogenes Laertius*, (*de vita Philosophor.*) hath preserved not only a faithful Catalogue of them, but hath also recorded their originals, declinations, periods, opinions.

Art. 1. The principal Sects of the *ancient* Grecian Philosophers, only enumerated.

Art. 2. The same revived among the *Moderns*, with encrease.

If we enquire into the *Modern* state of Learning, down even to our present age, we cannot but find not only the same Sects revived, but also many more New ones sprung up: as if Opinion were what mysterious Poets intended by their imaginary *Hydra*; no sooner hath the sword of Time cut off one head, but there grows up two in the place of it; or, as if the vicissitudes of Corruption and Generation were in common as well to Philosophy, as the subject of it, Nature. Insomuch as that Adage, which was principally accommodated and restrained to express the infinite dissention of Vulgar and Unexamining Heads, *Tot sententiæ quot homines*; may now justly be extended also to the *Scholiarchs* and professed enquirers into the Unitie of Truth. To enumerate all these Modern dissenting Doctors (the most modest of all which hath not blushed to hear his pedantique Disciples salute him with the magnificent Attributes of a Despot in Physiologie, and the only Cynosure by which the benighted reason of man may hope to be conducted over the vertiginous Ocean of Error, to the Cape of Veritie) is neither useful to our Reader, nor advantageous or pertinent to our present Design. But, to reduce them to *four General Orders*, or range them into four principal Classes; as it may in some latitude of interest, concern the satisfaction of those who are less conversant among Books: so can it in no wise affront the patience of those, whose studies have already acquainted them with the several kinds of Philosophy now in esteem.

Art 3. Who are reduced either to the *Pedantique* or *Female* Sect.

1 Some there are (and those not a few) who in the minority of their Understandings, and while their judgments are yet flexible by the weak fingers of meer Plausibilitie, and their memories like Virgin wax, apt to retain the impression of any opinion that is presented under the specious disguise of Verisimilitie only; become constant admirers of the first Author, that pleaseth them, and will never after suffer themselves to be divorced from his principles, or to be made Proselytes to Truth; but make it the most serious business of their lives to propugne their Tutors authoritie, defend even his very errors, and excogitate specious subterfuges against those, who have with solid Arguments and Apodictical reasons, clearly refuted him. These stifle their own native habilities for disquisition, believe all, examine nothing; and, as if the Lamp of their own Reason were lent them by their Creator for no use at all, resign up their judgments to the implicite manuduction of some other; and all the perfection they aim at, is to be able to compose unnecessary, and perhaps erroneous Commentaries upon their Masters text. This easie Sect may, without much either of incongruitie or scandal, be named *Secta* θηλυθρώνης, the FEMAL Sect; because as women constantly retain their best affections for those who untied their Virgin Zone; so these will never be alienated from immoderately affecting those Authors who had the Maiden-head of their minds. The chiefest Chair in this Classis ought to be consigned to our *Junior Aristoteleans*, who villifie and despise all doctrine, but that of the *Stagirite*, and confidently measure all mens deviations from truth, by their recessions from his dictates. This we say not to derogate from the honour due to so great a Clerk; for we hold it our duty to pay him as large a tribute of Veneration, as any man that ever read his excellent Writings, without prejudice, and esteem him as one of the greatest and brightest stars in the sphere of Learning; nay we dare assert, that He was the Centre in which all the choicest speculations

culations and observations of his Prædecessors were united, to make up as complete abody of Natural Science, as the brain of any one single person, wanting the illumination of *Sacred Writ*, seems capable of, in this life of obscuritie: and that He hath won the Garland from all, who have laboured to invent and præscribe a general Method for the regulation and conduct of mens Cogitations and Conceptions. But, that I am not yet convicted, that his judgment was superior to mistake; that his Writings, in many places more then obscure, can well be interpreted by those who have never perused the Moniments of other Ancients; nor, that it can consist with Ingenuity to institute a Sacrament in Philosophy, (*i.e.*) to vow implicite vassalage to the Authoritie of any man, whose maxims were desumed from no other Oracle, but that of Natural Reason only; and to arrest all Curiositie, Disquisition, or Dubitation, with a meer ἀυτὸς ἔφα.

Hither may we refer also the patient Interpreters of *Scotus*; the vain Idolaters of *Raimund Lully*; but, above all, the stupid admirers of that Fanatick Drunkard, *Paracelsus*. In whose whole life, the only Rarities any sober man can discover, were his Fortune, and his Impudence. His *Fortune*, in that he being an absolute bankrupt in merit, could be trusted with so large a stock of Fame: his *Impudence*, in that, being wholly illiterate (for in stead of refining, He much corrupted his mother-tongue) He should prætend to subvert the Fundamentals of *Aristotle* and *Galen*, to reform the Common-weal of Learning, consummate the Arts and Sciences, write Commentaries on the *Evangelists*, and enrich the world with *Pansophy* in Aphorisms.

(2) Others there are (and those too few) whose brests being filled with true Promethean fire, and their minds of a more generous temper, scorn to submit to the dishonourable tyranny of that Usurper, Autority, and will admit of no Monarchy in Philosophy, besides that of Truth. These ponder the Reasons of all, but the Reputation of none; and then conform their assent, when the Arguments are nervous and convincing; not when they are urged by one, whose Name is inscribed in Golden Characters in the Legend of Fame. This Order well deserves the Epithite, Βεβαιωτικὸς, and therefore we shall Christen it, The Order of the ASSERTORS OF PHILOSOPHICAL LIBERTY; in regard, they vindicate the native privilege of our Intellectuals, from the base villenage of Præscription. Of this Order, Gratitude it self doth oblige us to account the Heroical *Tycho Brahe*, the subtle *Kepler*, the most acute *Galilæus*, the profound *Scheinerus*, the miraculous because universally learned *Kircherus*, the most perspicacious *Harvey*, and the Epitome of all, *Des Cartes*. In honour of each of these Hero's, we could wish (if the constitution of our Times would bear it) a Colossus of Gold were erected at the publick charge of Students; and under each this inscription:

Art. 4. Or, to the *Assertors of Philosophical Liberty.*

Amicus Plato, amicus Aristoteles, magis amica veritas.

(3) The third Classis is possessed by such, who, without either totally neglecting or undervaluing the Inventions and Augmentations of the Modern; addict themselves principally to research the Moniments of the *Ancients*, and dig for truth in the rubbish of the *Grecian Patriarchs*. These are the noblest sort of *Chymists*, who labour to reform those once-excellent Flowers out of their Ashes: worthy *Geometricians*, that give us the true

Art. 5. Or, to the *Renovators.*

 dimensions

dimensions of those Giant Wits, by the measure of their Feet: and genuine sons of *Æsculapius*, who can revive those, whom the fleet chariot of Time hath dragg'd to pieces, and recompose their scattered fragments into large and complete bodies of Physiologie. The Course of these Worthies in their studies doth denominate them Ἀναλαμπτοί, RENOVATORS.

For, being of opinion, that Philosophy as well as Nature doth continually decline, that this is the Dotage of the World, and that the minds of men do suffer a sensible decay of clarity and simplicity; they reflect their thoughts upon the πῆξις, or *Epoche* of *Physical Writings*, ransack the urns of *Athens* to find out the medal of some grave Philosopher, and then with invincible industry polish off the rust, which the vitriolate dampness of Time had superinduced; that so they may render him to the greedy eyes of Posterity in his primitive splendor and integrity. The uppermost seats in this infinitely-deserving Classis justly belong to *Marcilius Ficinus*, who from many mouldy and worm-eaten Transcripts hath collected, and interpreted the semidivine Labors of *Plato*: to *Copernicus*, who hath rescued from the jawes of oblivion, the almost extinct Astrology of *Samius Aristarchus*: to *Lucretius*, who hath retrived the lost Physiologie of *Empedocles*: to *Magnenus*, who hath lately raised up the reverend Ghost of *Democritus*: to *Mersennus*, who hath not only explained many Problems of *Archimed*; but renovated the obsolete Magick of Numbers, and charmed the most judicious ears of Musitians, with chiming *Pythagoras* Hammers, in an Arithmetick Harmony: and to the greatest Antiquary among them, the immortal *Gassendus*; who, out of a few obscure and immethodical pieces of him, scattered upon the rhapsodies of *Plutarch* and *Diogenes Laertius*, hath built up the despised *Epicurus* again, into one of the most profound, temperate, and voluminous among Philosophers.

Art. 6. Or to the *Electors.*

Our Fourth Classis is to be made up of those, who indeed adore no Authority, pay a reverend esteem, but no implicite Adherence to Antiquity, nor erect any Fabrick of Natural Science upon Foundations of their own laying: but, reading all with the same constant Indifference, and æquanimity, select out of each of the other Sects, whatever of Method, Principles, Positions, Maxims, Examples, &c. seems in their impartial judgments, most consentaneous to *Verity*; and on the contrary, refuse, and, as occasion requires, elenchically refute what will not endure the Test of either right *Reason*, or faithful *Experiment*. This Sect we may call (as *Potamon Alexandrinus*, quoted by *Diogenes Laertius*, long before us) Ἐκλεκτικὴ the ELECTING, because they cull and select out of all others, what they most approve.

Herein are Chairs provided for those Worthies, *Fernelius*, *Sennertus*, and most of the junior Patriots and Advancers of our Art. And the lowest room, we ask leave to reserve for our selves. For we profess our selves to be of his perswasion, who saith; *Ego quidem arbitror, re diu perpensâ, nullius unquam scientiam fore absolutam, quin Empedoclem, Platonem, Aristotelem, Anaxagoram, Democritum adjungat Recentioribus, & ab unoquoque quod verum est, rejectis falsis, eligat. His enim Principibus peculiari ratione Cæleste Lumen affulsit: & quamvis Corporis imbecilitate multa corruperint; plurima tamen, quæ Fidei lumine discernimus, scripsêre verissima* He can never make a good *Chymist*, who is not already an excellent *Galenist*, is proverbial among us Physicians: and as worthy the reputation of a Proverb is it among Professors in Universities; He can never clearly understand the

the *Moderns*, who remains ignorant of the doctrines of the *Antients*. Here to declare our selves of this Order, though it be no dishonour, may yet be censured as superfluous: since not only those Exercises of our Pen, which have formerly dispersed themselves into the hands of the Learned, have already proclaimed as much; but even this præsent Tractate must soon discover it.

SECT. II.

TO explore the Cheif Grounds, or Reasons of this great Varietie of Sects in Philosophy; we need search no further, then the exceeding *Obscurity of Nature*, the *Dimness and imperfection of our Understanding*, the *Irregularity of our Curiosity*.

Art. 1. The principal causes of the Diversity of Philosophical Sects; and the chiefest among them, the *Obscurity of Nature*

Of the *First*, they only can doubt, who are too stupid to enquire. For, Nature is an immense Ocean, wherein are no Shallows, but all Depths: and those ingenious Persons, who have but once attempted her with the sounding line of Reason, will soon confess their despair of profounding her, and with the judicious *Sanchez* sadly exclaim; *Una Scientia sufficit toti orbi: nec tamen totus hic ei sufficit. Mihi vel minima mundi res totius vitæ contemplationi sat est superque: nec tamen tandem eam spero me nosse posse:* nor can they dislike the opinion of the *Academicks* and *Pyrrhonicks*, that all things are Incomprehensible.

Art. 2. The *Imperfection of our Understanding.*

And (as for the *second*) if Nature were not invelloped in so dense a Cloud of Abstrusity, but should unveil her self, and expose all her beuteous parts naked to our speculation: yet are not the Opticks of our Mind either clear or strong enough to discern them. Men indeed fancy themselves to be Eagles; but really are grovelling Moles, unceßantly labouring for light: which at first glimpse perstringeth their eyes, and all they discover thereby, is their own native Blindness. *Naturæ mysteria etiamsi mille facibus revelentur, arbitrantium oculis numquam totà excipientur: restabit semper quod quæras; & quo plus scies, eo plura à te ignorari miraberis.* This meditation, we confess, hath frequently stooped our ambitious thoughts, dejected us even to a contempt of our own nature, and put us to a stand in the midst of our most eager pursuit of Science: insomuch that had not the inhærent Curiosity of our Genius sharply spurred us on again, we had totally desisted, and sate down in this resolution; for the future to admire, and perhaps envy the happy serenity of their Condition, who never disquiet and perplex their minds with fruitless scrutiny, but think themselves wise enough, while they acquiesce in the single satisfaction of their Senses. Nor do we look ever to have our Studies wholly free from this Damp: but expect to be surprised with many a cold fit, even then when our Cogitations shall be most ardent and pleasing. And to acknowledge our pensive sense of this Discouragement, is it that we have chosen this for our Motto: *Quo magis quærimus, magis dubitamus.*

But lest this our despair prove contagious, and infect our Reader, and He either shut up our Book, or smilingly demand of us, to what purpose

purpose we wrote it; if (as we confess) Insatisfaction be the End of study, and (as we intimate) our Phisiology at most but ingenious Conjecture: we must divert him with the novelty of a Paradox, *viz.* that the *Irregularity of our Curiosity is one Cause of the Dissent of Philosophers.*

Art. 3. The *Irregularity of our Curiosity.* A paradox.

That our desire of Truth should be a grand Occasion of our Error; and that our *First Parents* were deluded more by the instigation of their own essential CURIOSITY, than by either the allurement of their Sensual Appetite, or the subtle Fallacies of the Serpent: is a conceit not altogether destitute of the support and warrantry of Reason. For, the Human Soul (the only Creature, that understands the ἔξοχη, or transcendent Dignity of its Original, by reflecting upon the superlative *Idea*, which it holds of its Creator) from the moment of its immersion into the cloud or opacity, of flesh labours with an insatiable Appetence of Knowledge; as the only means, that seems to conduce to the satisfaction of its congenial Ambition of still aspiring to Greater and Better things: and therefore hath no Affection either so Essential, or Violent, as the Desire of Science; and consequently, lyeth not so open to the deception of any Objects, as of those which seem to promise a satisfaction to that desire. And obvious it is from the words of the Text; that the Argument which turned the scales, *i.e.* determined the Intellect, and successively the Will of our Grandmother *Eve*, from its indifferencie, or æquilibration, to an Appetition, and so to the actual Degustation of the Forbidden Fruit, was this: *Desiderabilis est arboris fructus ad habendam scientiam.* Besides, though we shall not exclude the Beauty of the fruit, transmitted by the sight to the judicatory Faculty, and so allecting the Sensual Appetite, from having a finger in the Delusion; yet can we allow it to have had no more then a finger; and are perswaded, that in the syndrome or conspiracy of Causes, the most ponderous and prævalent was the Hope of an accession or augmentation of *Knowledge.* Since it cannot but highly disparage the primitive or innocent state of man, to admit, that his Intellect was so imperfect, as not to discern a very great Evil, through the thin Apparence of Good, when the utmost that Apparence could promise, was no more, than the momentany pleasure of his Palate or Gust: Or, that the express and pœnal Interdiction of God, yet sounding in his ears, could be over-balanced by the light species of an object, which must be lost in the Fruition.

Nor is this *Curiositie* to be accused only of the First Defection from Truth, but being an inseparable Annex to our Nature, and so derived by traduction to all *Adams* posteritie, hath proved the procatarctick Cause of many (some contemplative Clerks would have adventured to say of All) the *Errors* of our judgments. And, though we have long cast about, yet can we not particular any one Vicious inclination, or action, whose Scope or End may not, either directly or obliquely, proximly or remotely, seem to promise an encrease of *Knowledge* in some kind or other. To instance in one, which appears to be determined in the Body, to have no interest beyond the Sense, and so to exclude all probabilitie of extending to the Mind, as to the augmentation of its Science. Whoever loves a beutiful Woman, whom the right of Marriage hath appropriated to another, ardently desires to enjoy her bed; why, not only for the satisfaction of his sensual Appetite, because that might be acquired by the act of carnality with

with some other less beutiful, and Beuty is properly the object of the Mind: but because that Image of Beuty, which his eye hath transmitted to his mind, being præsented in the species or apparition of Good and Amiable, seems to contain some Excellence, or comparitively more Good, then what He hath, formerly understood. If it be *objected*, that if so, one enjoyment must satisfie that Desire; and consequently, no man could love what He hath once enjoyed, since Fruition determineth Desire: We *Answer*, that there is no such necessitie justly inferrible, when Experience assures, that many times Love is so far from languishing, that it grows more strong and violent by the possession of its Object. The Reason is, because the passionate Lover, apprehending no fruition total, or possession entire, supposeth some more Good still in the object, then what his former enjoyment made him acquainted withall. And if it be *replyed*, that the Lover doth, in the perseverance of his Affection, propose to himself meerly the *Continuation* of that Good, which He hath formerly enjoyed: we are provided of a sufficient *Rejoynder*, *viz.* that whoso wisheth the Continuation of a Good, considers it not as a thing præsent, but to come; and consequently as a thing which yet He doth not know: for, no man can know what is not.

Other Instances the Reader may be pleased to select from among the *Passions*; tracing them up to their first Exciting Cause, in order to his more ample satisfaction: it being digressive and only collateral to our Scope. Good thus being the only proper Object of our Affections (for Evil exhibited naked, *i. e.* as Evil, never Attracts, but ever Averts our Will, or Rational Appetite: as we have clearly proved in our Discourse of the *Liberty Elective of mans Will.*) if we mistake a real evil præsented under the disguise of a Good: this mistake is to be charged upon the account of our Rational or judicatory Faculty, which not sufficiently examining the Reality of the species, judgeth it to be good, according to the external Apparence only; and so misguideth the Will in its Election. Now, among the Causes of the Intellects erroneous judicature (we have formerly touched upon its own *Native Imperfection*, or *Cæcity*, and *Præjudice*,) the chiefest and most general is the *Impatience*, *Præcipitancy*, or *Inconsiderateness* of the Mind; when, not enduring the serious, profound, and strict examen of the species, nor pondering all the moments of Reason, which are on the Averting part of the Object, with that impartialiry requisite to a right judgment; but suffering it self, at the first occursion or præsentation thereof, to be determined, by the moments of Reason apparent on the Attracting part, to an Approbation thereof: it misinformeth the Will, and ingageth it in an Election and prosecution of a Falsity, or Evil, couched under the specious semblance of a positive Truth, or Good.

Now, to accommodate all this to the interest of our *Paradox*; if Good, real or apparent, be the proper and adæquate object of the Intellect; and the chief reason of Good doth consist in that of Science, as the principal end of all our Affections: then, most certainly, must our præcedent assertion stand firm, *viz. that our understanding lyeth most open to the delusion of such objects, which by their Apparence promise the most of satisfaction to our Desire of Science*; and, upon consequence, by how much the more we are spurred on by our *Curiosity*, or Appetence of Knowledge, by so much the more is our mind impatient of their strict examen, and æquitable perpension. All which we dayly observe experimented in our selves.

selves. For, when our thoughts are violent and eager in the pursuit of some reason for such or such an operation in Nature; if either the discourse, or writings of some Person, in great esteem for Learning or Sagacity, or our own meditations furnish us with one, plausible and verisimilous, such as seems to solve our Doubt: how greedily do we embrace it, and without further perpension of its solidity and verity, immediately judge it to be true, and so set up our rest therein? Now, it being incontrovertible, that Truth consists in a Point, or Unity; it remains as incontrovertible, that all those judgements, which concur not in that Point, must be erroneous: and consequently that we ought ever to suspect a multiplicity of dissenting judgments, and to suppose that Phænomenon in Nature to be yet in the dark, *i. e.* uncomprehended, or not understood, concerning whose solution the most various opinions have been erected.

And thus have we made it out; that our Curiosity is the most frequent Cause of our Minds Impatience or Præcipitancy: that Præcipitancy the most frequent Cause of our Erroneous jdugments, concerning the Verity or Falsity of Objects: those Erroneous judgments alwayes the Cause of the Diversity of Opinions: and the Diversity of Opinions alwayes the Cause of the Variety of Sects among Philosophers.

CHAP.

CHAP. II.

That this World is the Universe.

SECT. I.

Among those Fragments of Antiquity, which History hath gathered up from the table of sated Oblivion, we find two worthy the entertainment of our Readers memory, though, perhaps, not easie to be digested by his Belief. The *one* that *Alexander* the Great grew melancholy at the lecture of *Anaxarchus* his discourse of an *Infinity of Worlds*, and with tears lamented the confinement of his Ambition to the Conquest of One: when yet, in truth, the wings of his Victory had not flown over so much as a third part of the Terrestrial Globe; and there remained Nations more then enough to have devoured his numerous Armies at a breakfast, to have learned him the unconstancy of Fortune, the instability of Empire, and the vanitie of Pride, by the experiment of his own overthrow, and captivity in a narrow prison. The *Other*, that there were whole Schools of *Philosophers*, who fiercely contended for a *Plurality* of *Worlds*, and affected the honour of invincible Wits, by extending their disquisitions beyond the Extrems or Confines of this adspectable World to a multitude of others without it, as vast, as glorious, as rich in variety of Forms: when, indeed, their Understandings came so much short of conquering all the obvious Difficulties of this one, that even the grass they trod on, and the smallest of Insects, a Handworm, must put their Curiosity to a stand, reduce them to an humble acknowledgment of their Ignorance, and make them sigh out the Scepticks Motto, *Nihil Scitur*, for a Palinodia. Whether His or Their Ambition were the greater, is not easie to determine; nor can we find more wildness of Phansy, or more insolent Rhodamontadoes in Camps, than Academies, nay if we go to Absurdities, *Cedunt Arma Togæ*, the Sword must give place to the Gown. But, that his Error was more venial then theirs, is manifest from hence; that He had conquered all of the World that he knew: but they could not but find themselves foiled and conquered by every the most minute and sensible part of the world, which they had attempted to know.

Art. 1. The Ambition of *Alexander* in affecting the Conquest, less vain then that of many ancient *Philosophers* in affecting the Knowledge of a *Multitude* of *Worlds*.

This *Genus* of Philosophers doth naturally divide it self into two distinct *species*. The *First* of which doth consist of those, who assert only a *Plurality* of Worlds: the *Second* of those, who have been so bold as to ascend even to an *Infinity*. Those who assert only a Plurality may be again sub-

Art. 2. A reduction of those Philosophers to four distinct Sects; respective to their distinct persuasions: and the *Heads* of each Sect nominated.

subdistinguished into two subordinate divisions: (1) Such as held a Plurality of Worlds *Coexistent*; among whom the most eminent was *Plutarch*, who (*in lib. de Oracul. defect.*) affirms, that to have many Worlds at once, was consistent with the majesty of the Divine Nature, and consonant to Human Reason; and (in 1. *placit.* 5.) earnestly labours to dissolve the contrary Arguments of *Plato* and *Aristotle* for the Unity of the World. Nor were these all of one Sect; for *some* opinioned that there were many other Worlds synchronical in the Imaginary space, or on the outside of this: and *others* would admit of nothing, beyond *Trismegistus* Circle, or without the convex part of the *Empyræum*; but conceived that every Planet, nay, every Star, contained in this, was an intire and distinct World. Among these the Principal were *Heraclides*, the *Pythagoreans*, and all the Sectators of *Orpheus*: as they are enumerated by *Plutarch* (2 *Placit.* 13.)

(2) Such as held a Plurality of worlds, not coexistent or synchronical, but *successive*; *i.e.* that this præsent world, Phœnix-like, sprung up from the ruines of another præcedent; and that the Ashes of this shall produce a Third, the Cinders of that a Fourth, &c. of this perswasion were *Plato*, *Heraclitus*, and all the *Stoicks*.

The *Second* species is made up of those, who dreamt of an *Infinity* of Worlds coexistent in an infinite space: and the chief seats in this Classis belong to *Epicurus* and *Metrodorus*, upon the last of which this peremptory saying is commonly fathered; Ἄλοπον εἶ ἐν μεγάλῳ πεδίῳ ἕνα σάχον θερίζειν καὶ ἕνα κόσμον ἐν τῷ ἀπείρῳ. *Tam absurdum esse in Universo infinito unum fieri mundum, quàm in magno agro unam nasci spicam.* And below them shall sit *Anaximander*, *Anaximenes*, *Archelaus*, *Xenophon*, *Diogenes*, *Leucippus*, *Democritus*, and *Zeno Eleates*, as may be collected from the records of *Stobæus* (*Ecl. Physic. l. 9.*) That *Epicurus* was a grand Patron of this Error, is confest by himself (*in Epist. ad Herodotum, apud Laertium*) in these words: Ἄλλα μὴν καὶ κόσμοι ἄπειροι εἰσὶν οἵθ' ὅμοιοι τούτῳ εἰσὶ καὶ ἄνομοιοι, *Cæterum in universitate, seu natura rerum, infiniti sunt mundi, alij quidem similes isti quem nos incolimus, alij verò dissimiles.*

Art. 3. The two main pillars on which the opinion of a Plurality of Worlds was ancientlyerected.

The Reasons, or rather the Apparences of Reason, which seduced the Understandings of so many and great Philosophers into a judgment, that there was an Infinity of Worlds; are comprehended under these Two.

(1) *Quod Caussæ sunt infinitæ. Nam si hic quidem mundus sit, finitus Caussæ verò, ex quibus est, fuêre omninò infinitæ: necesse est mundi etiam sint infiniti. Prorsus enim, ubi sunt Caussæ, Effectus quoque ibi sunt.* That Worlds there are infinite in multitude, is manifest from hence, that there are infinite Causes for Worlds: for, since this World is finite, and the Causes of which it was made, were infinite; necessary it is that there be infinite Worlds. Insomuch as where are Causes, there also must be Effects. This *Epicurus* more then intimated, when He argued thus: *Quippe Atomi, cum sint infinitæ, per infinitatem spatiorum feruntur, & alibi aliæ, ac procul ab hoc ad fabricationem mundorum infinitorum variè concurrunt.* Consule *Plutarchum*, (1. *Placit.* 5.) & *Lucretium.* (*lib.* 2.)

(2) *Quod nulla sit specialis res, cui non suo sub genere sint singularia multa similia:* That there is no one thing special, to which under that kind, many singulars are not alike. Upon this sand was it that *Plutarch* erected his feeble structure of a Plurality of Worlds; for (*in defect. Oracul.*) he expresseth

presseth it at large, in these words, *Videmus naturam ipsis generibus, speciebusque, quasi quibusdam vasculis aut involucris seminum, res singulares continere. Neque enim res ulla est numero una, cujus non sit communis ratio, neque ulla certam denominationem nanciscitur, quâ singularis tum sit, non etiam communem qualitatem habeat. Quare & hic mundus, ita singularitèr dicitur, ut communem tamen rationem, qualitatemque mundi obtineat: singularis autem conditionis fit, ex differentia ab alijs quæ ejusdem Generis sunt. Et certè non unicus Homo, non unicus Equus, non unicum Astrum, non unicus Deus, non unicus Dæmon in rerum natura est: quid prohibit, quo minus plures, non unicum mundum Natura contineat, &c.*

SECT. II.

The Redargution.

THat our *Redargution* of this vain *Error* may obtain the more both of *Perspicuity* and *Credit*, we are to advertise that the *Question* is not concerning the *Possibility*, but the real or actual *Existence* of an *Infinity* of *Worlds*. For, of the *Possibility*, no man, imbued with the principles of Physiology, or Theology, can doubt.

Art. 1. The Question stated to be concerning the real *Existence*, not the *possibility* of an Infinity of Worlds

(1) Because, to the most profound and nice Enquirers into that abstruse point, no Argument, whether simple or complex, hath appeared weighty enough to dissuade them from admitting an *immense Tohu*, or *infinite Vacuum*, without the extremities of this World. For, not a few, nor the least judicious part of even our Christian Doctors have asserted those *Extramundane spaces* calling them IMAGINARY; because we can imagine the same Dimensions of Longitude, Latitude, and Profundity, to be in them, as are in those real Spaces, wherein Bodies are included in this world: and since all men, acknowledging the Omnipotence of God, conclude, that He might, had He so pleased, have created this World larger and larger even to infinity; necessary it is, that they also admit a larger and larger *space* or Continent, for the Reception of that enlarged World. Which may with equal Truth be accommodated also to an *Infinity* of Worlds; insomuch as all, who acknowledge Gods *Omnipotence*, readily condescend, that He could, had it seemed good in the eye of his Wisdom, have created more and more Worlds, even to Infinity: necessary it is, that they understand those Worlds must be received in proportionate spaces, which ought to be over and above that space, which this World possesseth. For, whereas some have conceived, that if God would create more Worlds besides this, He must also create more spaces to contain them: undoubtedly they entangle themselves in that inextricable Difficulty which is objected upon them, concerning the space interjected between any two Worlds; since that space may be brought under the laws of Mathematical Commensuration, and clearly explained by a greater or less Distance.

Art. 2. Because the supposed *Infinity* of the *Extramundan Spaces*, is no impossibility.

(2) Because, it is found no ἀμήχανον, or desperate Difficulty to defend a *Possible Infinity of Bodies*. For the Fathers of our Church have delivered it as Canonical, that God might have created any thing Actually Infinite

Art. 3. Because an *Infinity* of *Bodies* is also possible; as to the Omnipotence of God.

nite not only in Magnitude, but also in Multitude. Only they reserve the infinity of *Essence*; which since it can be competent to none but the *Divine Essence*, and comprehends all perfections whatever in a most transcendent or Eminent manner: it is as absolutely impossible that any thing should be Created *Actually Infinite in Essence*, as that God should be created. Which we conceive to be the ground of that Truth; that *to imagine God to be able to create any thing equal to Himself: is to suppose an Imperfection in his Nature.* Nor have They, without good Cause, deserted the conduct of *Plato* and *Aristotle*, when they would seduce them into an opinion, that Infinity is only *Potential*, not Actual, *i. e.* that nothing *in Rerum Natura* can be infinite *in Actu*, but only *in Potentia*; insomuch as though a *Continuum* may be either divided, or Augmented even to Infinity: yet cannot that *Continuum* either by Division, or Augmentation, ever become Actually infinite. For, since even *Aristotle* himself describes an *Infinite* to be, *non cujus extra nihil est, sed ex quo accipientibus semper aliquid accipiendum restat*, that from which though nere so much be abstracted, yet still there shall more remain undeducted; which is, in the sum or importance, to say that the Essence of Infinity is *Inexhauribility*: it seems possible to admit not only many, but even infinite infinities in an Infinite. Thus we say, and truly, that in an infinite *Number* are comprehended not only infinite *Unities*, but also infinite *Binaries*, infinite *Ternaries*, infinite *Denaries, Centenaries, &c.* which is the reason of that Axiom, *That all the parts of an Infinite are Infinite.*

Art. 4. The Error of concluding the *Esse*, from the *Posse* of an Infinity of Worlds

Now though to be able, by perfect *Demonstration*, to evince that there are no more Worlds but this one, which we inhabit, is that of which to despair can be no dishonour to the most acute and Mathematical Wit in the world; since none ought to doubt, but God might have created, and may yet at his pleasure create others innumerable, because neither can His *Infinite Power* ever be exhausted, nor that *Abyss* of *Nothing*, out of which the Energie of his Word instantly educed this World, not afford or space or matter for them: yet notwithstanding to affirm, that because 'tis *possible* therefore there *are* many other Worlds actually coexistent; is a manifest *inartificial Argument*, and a Conclusion repugnant to all the inducements of Persuasion.

For, albeit we readily concede, that there is an *Infinite Inanity* or Ultramundan Space, yet can it not follow of necessity, that there are *Infinite Atoms* contained in that Ultramundane Space; as *Democritus* and *Epicurus* præposterously infer: insomuch as it sounds much more concordant to reason, that there are no more Atoms, then those of which this single World was compacted.

Art. 5. The *first* main Pillar of a Plurality of Worlds subverted.

And when they Argue thus; *Since the vacuity or ultramundane Space is infinite in Magnitude or Capacity, necessary it is that the Abyss of Atoms included therein be also Infinite in Extent; because otherwise they could never have convened, and coalesced in that Form, which the World now holds:* we admit their *Induction* for natural and legitimate, but detest their *supposition* as absurd and impossible. For, They take it for granted, that the Chaos of Atoms was not only eternal and *Increate*, but also that it disposed, and compacted it self into that Form, which constitutes the World, by the spontaneous motion inhærent in Atoms, and their fortuitous coalescence in such and such respective Figures: when to a sober judgment

judgment it appears the highest *Impossibility* imaginable, that either the Chaos of Atoms could be eternal, self-principate, or increate, or dispose and fix it self into so vast, so splendid, so symmetrical, so universally harmonical, or Analogical a structure, as this of the World. For, as the *Disposition* or Dispensation of the Chaos of Atoms into so excellent a form, can be ascribed to no other Cause, but an *Infinite Wisdom*: so neither can the *Production* or Creation of the same Chaos be ascribed to any other Cause, but an *Infinite Power*, as we have formerly demonstrated in our *Darkness of Atheism, cap.2.*

And therefore, since it is most probable that Atoms were the *Materia Prima*, or material Principle of the World; as we shall clearly enunciate in a singular Chapter subsequent: we may adventure to affirm, that God created exactly such a proportion of Atoms, as might be sufficient to the making up of so vast a Bulk, as this of the World, and that there remained no one superfluous. 'Tis unworthy a Philosopher to acknowledge any superfluity in Nature: and consequently a dangerous solœcism to say the *God* of Nature knowing not how to proportion the quantity of his materials to the model or platform of his structure, created more Atoms, then were necessary, and left an infinite Residue to be perpetually hurried too and fro in the ultramundane space. If they shall *urge* upon us, that no man was privy to the Councel of God at the Creation, and consequently no can know, whether He created either more Atoms then were requisite to the amassment of this World, or more Worlds then this one: we may justly *retort* the Argument upon them, and conclude, that since no man was privy to the Councel of God, they have no reason to pretend to know, that God created either more matter, or more Worlds; and so the whole substance of the Dispute must be reduced only to this: That they have no more Reason for the support of their opinion of a Plurality of Worlds then we have for ours of the Unity of the World. Nay the greatest weight of Reason hangs on our end of the scale; for, we ground our Opinion upon that stable Criterion, our *sense*, and asserting the singularity of the world, discourse of what our sight apprehends: but They found theirs upon the fragil reed of wild Imagination, and affirming a Plurality discourse of what neither the information of their sense, nor solid reason, nor judicious Authority, hath learned them enough to warrant even Conjecture.

Art. 6. The *second* Pillar found sophisticate, and demolished.

And, as to their second *Argument*, viz. *That there is in Nature no one Thing special, to which under the same kind, there are not many singulars alike*: we *Answer*, that All those *singulars*, which we observe to be multiplied under one and the same kind, are such which perish in the *Individual*, and therefore cannot but be lost, if not conserved by the multitude of Successors; and not such as are not obnoxious to destruction by Corruptibility, for they, constantly existing in the Individual, need not Multiplicity to their conservation. For which cause, one Sun, and one Moon are sufficient, and in al probability of this sort is the World; for though it be conceived obnoxious to corruption, and shall once confess a *Period*: yet is this no valid reason to justifie the necessity of a multitude of worlds, since the Dissolution of the World shal be synchronical to the Dissolution of Nature, when Sun, Moon, and all other kinds of Creatures, as well single as numerous shall be blended together in one common ruine; and then the same *Infinite Cause* which hath destroyed them, can, with as much facility as he first Created them, repair their

their ruines, educe them out of their second Chaos, and redintegrate them into what Form His Wisdom shall design.

Art. 7. A Plurality of Worlds manifestly repugnant to *Authority Divine*,

Nor is this opinion of a Plurality of Worlds only destitute of, but even *è diametro* repugnant to the principal *Inducements* of Belief. For, if we consider *Authority Divine*; in *Moses* inæstimable Diary or Narrative of the Creation can be found no mention at all of a Multitude of Worlds, but on the contrary a positive assertion of *one* world; and the express declarement of the manner how the *Fiat* of *Omnipotence* educed the several Parts thereof successively out of the Chaos, disposed them into subordinate Piles; and endowed them with exquisite configurations respective to their distinct destinations, motions and uses: and in all the other Books of Sacred Writ, whatever concerns the Providence of God, the Condition of man, the mysteries of his Redemption, means of salvation, &c. doth more then intimate the singularity of the World; nor is there any one word, if rightly interpreted, which can be produced as an excuse for the opposite Error.

Art. 8. And *Human.*

If *Humane Authority*; we may soon perceive, that those Ancient Philosophers, who have declared on our side, for the Unity of the World, do very much exceed those *Pluralists* nominated in our præcedent Catalogue, both in *Number* and *Dignity*. For, *Thales*, *Milesius*, *Pythagoras*, *Empedocles*, *Ecphantus*, *Parmenides*, *Melissus*, *Heraclitus*, *Anaxagoras*, *Plato*, *Aristotle*, *Zeno* the Stoick, attended on by all their sober Disciples, have unanimously rejected and derided the Conceit of many Worlds, not only as vain and weak, but as extremly Hypochondriack, and worthy a whole acre of Hellebor. Nor, indeed, are we persuaded, that so great Wits as those of *Democritus* and *Epicurus*, did apprehend it as real; but only Imaginary, proposing it as a necessary Hypothesis, whereon to erect their main Physical Pillar, τὸ ὅλον ἀγένητον εἶναι καὶ ἄφθαρτον, *Vniversum esse ortus interitusque expers*, That the Universe is nonprincipiate and indissoluble. For, having mediated thus; Whatever is Finite, is circumscribed by an External Space, from which a cause may come and invading destroy it, and into which the matter thereof, after the dissolution of its Form, may be received: now this World, being Finite, must be environed by a circumambient space, from which a Cause may invade and destroy it; and into which the matter thereof, after the dissolution of its Form, may be received; must of necessity therefore be dissoluble: They inferred, that, unless they would concede the Universe to be dissoluble, which could never consist with their Principles, they must affirm it to be Infinite, *i. e.* without which no space can be, from whence any Cause might invade it, and into which the matter thereof after the destruction of its Form, might be received: and thereupon concluded to suppose an Infinity of Worlds Coexistent.

Which seems to be the Reason also that induced *Epicurus* and *Metrodorus* to opinion, that the *Vniverse* was not only Ἀμετάβλητον *Immutable*; but also ἀκίνητον *Immoveable*: as may be collected from these words of *Plutarch* quoted by *Eusebius* (1. *præpa. Evang.* 5.) concerning *Metrodorus*, *Is inter cætera non moveri universum dixit quoniam non est quò migrare possit; nam si posset quidem, vel in plenum, vel in vacuum; atqui universum continet quicquid hujusmodi est, quia si non contineret, minimè foret Vniversum.*

Art. 9. The result of all; the Demonstration of the Authors Thesis, *That this World is the Universe.*

Having thus amply refuted the Dream of a Plurality of Worlds, both by detecting the exceeding invalidity of those two Cardinal Reasons, on which

which the Authors and Abettors of it had rashly fixed their Assent; and by convicting it of manifest Repugnancy to Authority Divine and Human: we may safely præsume, the understanding of our Reader is sufficiently præpared to determine his judgment to an Approbation of our Thesis, the Argument and Title of this Chapter, *viz.* That this Adspectable world is the τὸ πᾶν *Omne*, τὸ ὅλον *Vniversum*, the *All in Rerum Natura*, the large Magazine wherein all the wealth and treasure of Nature is included; and that there is Nothing Quantitative, but meerly Local, beyond the Convex extremity, or (as *Arist.*) τὴν ὑσίαν τ ἐσχάτης τ παντὸς περιφορᾶς, *substantiam quæ est in ultima Cœli conversione*; the outside of the *Empyræum*. Thus much *Aristotle*, though upon the conviction of other Arguments, seems fully to have both understood and embraced, when in positive terms He affirmed, μήτε εἶναι μεδὲν ἔξω Σῶμα τοῦ οὐρανοῦ, μήτε ἐνδεχεσθαι γιγνέσθαι· *Extra cœlum neque est quicquam Corpus, neque esse omninò potest* (*de cœlo l.*1. *c.*9.) As also whensoever He used those two words, τὸ ὅλον & ὁ κόσμος, *Vniversum* & *Mundus*, as perfect synonymaes, indifferently signifying one and the same thing: which was most frequent not only to him, but to *Plato* also, and most of the most judicious sort of Philosophers.

*Art.*10. Extramundane Curiosity, a high degree of *Madness*.

If any Curiosity be so immoderate, as to transgress the Limits of this All, break out of *Trismegistus* Circle, and adventure into the Imaginary Abyss of Nothing, vulgarly called the *Extramundan Inanity*; in the Infinity (or, rather, *Indefinity*) of which many long-winged VVits have, like seel'd Doves, flown to an absolute and total loss: the most promising Remedy we can præscribe for the reclaiming of such wildness; is to advertise; that a serious Diversion of thought to the speculation of any the most obvious and sensible of sublunary Natures, will prove more advantagious to the acquisition of Science, then the most acute metaphysical Discourse, that can be hoped from the groveling and limited Reason of man, concerning that imperveſtigable Abstrusity; of which the more is said, the less is understood; and that the most inquisitive may find Difficulties more then enough within the Little VVorld of their own Nature, not only to exercise, but empuzle them. To which may be annexed that judicious Corrective of *Pliny*, (*l.*2. *Nat.Hist.c.*1.) *Furor est, prefectò furor est egredi ex hoc mundo, & tanquam interna ejus cuncta planè jam sint nota, ita scrutari Extera. Quasi verò mensuram ullius possit agere, qui sui nesciat: aut mens Hominis videre, quæ mundus ipse non capiat.* And that facete scoff of the most ingenious Mr. *White* (*in Dialog.*1. *de mundo.*) That the Extramundan Space is inhabited by *Chymæra's* which there feed, and thrive to Giants upon the dew of *Second Intentions*.

CHAP.

CHAP. III.

Corporiety and Inanity.

Sect. I.

Art. 1. *Body* and *Inanity*, the two general Parts of the Universe.

THE Universe, or this adspectable World (henceforth Synonymaes) doth, in the general, consist of only two Parts, *viz.* Something and Nothing, or *Body* and *Inanity*. Τὴν τῶν ὄντων φύσιν σώματα εἶναι, καὶ κενόν, *Naturam rerum esse Corpora & Inane*, was the Fundamental position of *Epicurus* (*apud Plutarch. adverſ. Colot.*) which his faithful Disciple *Lucretius* hath ingenuosly rendred in this Distich:

Omnis, ut est igitur per se, Natura duabus
Consistit rebus; quæ Corpora sunt, & Inane.

The All of Nature in two Parts doth lye,
That is, in Bodies and Inanity.

Art. 2. Three the most memorable Definitions of *Corporiety* extant among Physiologists, recounted and examined.

Concerning the nature or essence of a BODIE, we find more then one Notion among Philosophers.

(1) Some understanding the root of *Corporiety* to be fixt in *Tangibility*: as *Epicurus* (*apud Empericum adverſ. Physic.*) saith, καὶ ἄθροισμον Σχήματος τε καὶ μεγέθους, καὶ ἀντιτυπίας, καὶ βάρους, τὸ Σῶμα νενοεῖσθαι: *intelligi Corpus ex congerie figuræ magnitudinis, resistentiæ* (*seu soliditatis ac impenetrabilitatis mutuæ & gravitatis*; that by Bodie is to be understood a congeries of figure, magnitude, resistence (or solidity and impenetrability mutual) and gravity.

To which *Aristotle* seems to allude (*in* 4. *Physic.* 7.) where He saith of those who assert a Vacuum, Σῶμα δὲ πάλιν ἅπαν οἴονται εἶναι ἅπτον· they conceive all Bodies to be Tangible: and *Lucretius*, *Tangere enim & tangi sine Corpore nulla potest res.* Here we are, *per transennam*, to hint; that the Authors of this Notion, do not restrain the *Tangibility* of Bodies only to the Sense of *Touching* proper to Animals; but extend it to a more general importance, *viz.* the *Contact of two Bodies reciprocally occurring* each to other *secundum superficies*; or what *Epicurus* blended under the word, Ἀντιτυπίας, Resistence mutual arising from Impenetrability.

(2) Others

(2) Others placing the Essential Propriety of a Body in its *Extension into the three Dimensions of Longitude, Latitude, and Profundity.* Thus *Aristotle* (*Nat. Auscult.* 4. *cap.* 3.) strictly enquiring into the Quiddity of Place, saith most profoundly; διαστήματα μὲν ὃν ἔχει τρία, μῆκος, καὶ πλάτος, καὶ βάθος, οἷς ὁρίζεται σῶμα πᾶν: *Sane Dimensiones tres habet, longitudinem, latitudinem, & altitudinem, quibus omne Corpus definitur.* And thus *Des Cartes* (*princip. Philos. Part.* 2. *Sect.* 4.) *Naturam materiæ, sive Corporis in universum spectati, non consistere in eo quod sit res dura, vel ponderosa, vel colorata, vel aliquo alio modo sensus afficiens; sed tantum in eo, quòd sit res extensa in longum latum & profundum*: that the Essence of matter, or a Body considered in the General doth not consist in its hardness, weight, colour, or any other relation to the senses; but only in its Extension into the three Dimensions.

And (3) Others, by an excessive acuteness of Wit, dividing the *Substance* of a Body from the *Quantity* thereof, and distinguishing *Quantity* from *Extension.* Of this *immoderately subtle* Sect are all those, who conceived that most Bodies might be so rarified and condensed, as that by *Rarefaction* they may acquire *more*, and by *Condensation less* of Extension, then what they have before in their native dimensions. We say *immoderately subtle*, because whoever shall with due attention of mind profound the nature of Rarefaction and Condensation, must soon perceive; that by those motions a Body doth suffer no more then a meer *Mutation of Figure*, but its Quantity admits of neither Augmentation, nor Diminution. So as those Bodies may be said to be *Rare*, betwixt whose parts many Intervals or Interstices, repleted with no Bodies, are interspersed; and those Bodies affirmed to be *Dense*, whose parts mutually approaching each to other, either diminish, or totally exclude all the Intervals or intercedent Distances. And when it eveneth, that the Intervals betwixt the distant parts of a Body, are totally excluded by the mutual access, convention and contact of its parts: that Body must become so absolutely, or (rather) superlatively Dense, as to imagine a possibility of greater Density, is manifestly absurd. But yet notwithstanding, is not that Body thus extremly Dense, of less *Extension*, then when having its parts more remote each from other, it possessed a larger space: in respect, that whatever of Extension is found in the Pores, or Intervals made by the mutually receing parts, ought not to be ascribed to the Body rarified, but to those small Inanities that are intercepted among the dissociated particles. For instance; when we observe a Sponge dipt in Liquor to become turgent and swell into a greater bulke; we cannot justly conceive, that the Sponge is made more Extense in all its parts, then when it was dry or compressed: but only, that it hath its pores more dilated or open, and is therefore diffused through a greater space. But we may not digress into a full examen of the nature of Rarefaction and Condensation; especially since the Syntax of our Physical Speculations will lead us hereafter into a full and proper consideration thereof.

Art. 3. Four Descriptions of the nature of *Inanity*, by *Epicurus*, *Cleomedes*, *Empiricus*, *Aristotle.*

Of the nature of the other ingredient of the Universe, INANITY, there are several Descriptions:

 (1) *Epi-*

(1) *Epicurus* names it χ᾽ χώραν, χ᾽ ἄναφη φύσιν, a *Region*, or *Space*, and *a Nature that cannot be touched:* thereby intimating the direct Contrariety betwixt the essential notion of Corporiety and Inanity; which Antithesis *Lucretius* plainly expresseth in that Verse, *Tactus coporibus cunctis intactus Inani.*

(2) *Cleomedes* describes a Vacuum to be, καθ᾽ ἑαυτὸν ἀσώματον, *ex sua natura incorporeum*: adding for furrher explanation, *siquidem est incorporeum, tactumque fugit, & neque figuram habet ullam, neque recipit, & neque patitur quicquam, neque agit, sed præbet solummodo liberum per seipsum corporibus motum*; it is incorporeal, because it cannot be touched, hath no figure of its own, nor is capable of any from others, neither suffers nor acts any thing, but only affords free space for the motion of other bodies through it.

(3) *Empiricus* (2. *adverſ Physic.*) descanting upon *Epicurus* description of Inanity, saith; *Natura eadem corpore destituta, appellatur Inane; occupata verò à corpore, Locus dicitur, pervadentibus ipsam corporibus evadit Regio:* the same Nature devoid of all body, is called a *Vacuum*, if possessed by a body, 'tis called a *Place*, and when bodies pervade it, it becomes a *Region.*

And (4) *Aristotle* (3.*Physic.*7.) defines a *Vacuum* to be *Locus in quo nihil est*, a Place wherein no body is contained.

Art. 4. Their importance extracted: and what is the formal or proper notion of a *Vacuum.*

Now if we faithfully extract the importance of all these several Descriptions of Inanity, we shall find them to concurr in this common Notion. As according to vulgar sense, a Vessel is said to be empty, when it being capable of any, doth yet actually contain no body: so, according to the sense of Physiology, that Place, that Region, or that Space, which being capable of bodies, doth yet actually receive or contain none, is said to be a *Vacuum* or Emptiness. Such would any Vessel be if upon remove of that body, whereby its capacity was filled, no other body, the Aer, nor ought else, should succeed to possess it: or such would that Space be, which this Book, that Man, or any other Body whatever doth now actually replenish, if after the remove of that Tenent, neither the circumstant Aer, nor ought else should succeed in possession, but it should be left on every side as it were limited by the same concave superficies of the circumambient, wherein the body, while a Tenent, was circumscribed and included.

Art. 5. The Existence of *Bodies* in the World, manifest by *Sense*: whose *Evidence* is perfect *Demonstration.*

Of the Existence of *Bodies* in the World, no man can doubt, but He who dares indubitate the testimony of that first and grand Criterion, *SENSE*, in regard that all *Natural Concretions* fall under the perception of some one of the Senses: and to stagger the Certitude of Sense, is to cause an Earthquake in the Mind, and upon consequence to subvert the Fundamentals of all Physical Science. Nor is Physiology, indeed, more then the larger Descant of Reason upon the short Text of Sense: or all our *Metaphysical* speculations (those only excluded, which concern the Existence and Attributes of the Supreme Being, the *Rational Soul* of man, and *Spirits*: the Cognition of the two former being desumed from proleptical or congenial impressions

ons implantate in, or coessential to our mind; and the belief of the last being founded upon Revelation supernatural) other then Commentaries upon the Hints given by some one of our External senses. Which Consideration caused *Epicurus* to erect these two Canons, as the Base of Logical Judicature.

(1)

Opinio illa vera est, cui vel suffragatur, vel non refragatur sensus evidentia.

(2)

Opinio illa falsa est, cui vel refragatur vel non suffragatur sensus evidentia.

That Opinion is true, to which the Evidence of Sense doth either assent, or not dissent: and that false, to which the evidence of Sense doth either not assent, or dissent.

By the *suffragation* or Assent of the Evidence of Sense, is meant an Assurance that our Apprehension or Judgment of any Object occurring to our sense, is exactly concordant to the reality thereof; or, that the Object is truly such, as we, upon the perception of it by our sense, did judge or opinion it to be. Thus *Plato* walking far off towards us, and we seeing him conjecture or opinion, as confidently as the great distance will admit, that it is *Plato*, whom we see coming toward us: but when, by his nearer approach, the great impediment of Certitude, Distance is removed; then doth the evidence of sense make an Attestation or suffragation of the verity of our opinion, and confirm it to be *Plato*, whom we saw.

The *Non-refragation* of Sense, intends the Consequution of some Inevident thing, which we suppose or præsume to be, with reflection upon something sensibly evident, or apparent. As when we affirm that there is a *Vacuum*; which taken singly, or speculated in its own obscure nature, is wholly inevident, but may be demonstrated by another thing sufficiently evident, *viz.* *Motion*: for if no Vacuum, no Motion; since the Body to be moved must want a Place, wherein to be received, if all Places be already full and crouded. Hence comes it that the thing Evident doth not *Refragari* to the Inevident. And thus the Suffragation and Nonrefragation of the Evidence of sense, ought to be understood as one *Criterion*, whereby any Position may be evicted to be true.

Hither alſo may be referred that *Tetraſtick* of *Lucretius*, (*lib.*1.)

Corpus enim per ſe communis deliquat eſſe
Senſus: quo niſi prima fides fundata valebit,
Haud erit, occultis de rebus, quò referentes
Confirmare Animi quicquam ratione queamus.

That *Bodies* in the World exiſtent are,
Our *Senſes* undeniably declare:
Whoſe Certitude once quæſtion'd; we can find
No judge to ſolve nice ſcruples of the *Mind*.

It remains therefore only that we prove (1) *That there is a Vacuum in Nature.* (2) *That there is in the Univerſe no Third Nature beſides that of Body and Inanity.*

CHAP.

CHAP. IV.

A Vacuum in Nature.

SECT. I.

IN order to our more prosperous Evacuation of that Epidemick Opinion, *Vacuum non dari in rerum natura*, that there is no Vacuity or Emptiness in the World; it is very requisite, that we præmise, as a convenient Præparative, this short advertisement.

Art. 1. The Distinction of a *Vacuum* into (1) *Natural*, and (2) *Præternatural*: and the one called *Disseminate*, the other *Coacervate*.

Among the speculations of many Ancient Physiologists, and especially of *Aristotle* (4. *Physic.* 6) we find a *Vacuum* distinguished into κατὰ φύσιν, & παρὰ φύσιν, *Secundum naturam*, & *Eternaturam*, a Vacuum consistent with, and a Vacuum totally repugnant to the fundamental constitutions of Nature. According to which proper distinction, we may consider a *Vacuum* (1) as παρεσπαρμένον, *Disseminatum*, *Interspersed*, or of so large diffusion as variously to interrupt the Continuity of the parts of the World. 2 As Ἀθροῦν, *Coacervatum*, *Coacervate* or separate from all parts of the World, such as the Ultramundan Space is conceived to be. Now, if we respect the *First* consideration or acception of a Vacuum, the Quæstion must be, *An detur vacuum Disseminatum?* Whether there be any small Vacuity in nature, or more plainly, Whether among the incontinued particles of Bodies there be any minute insensible Spaces intermixed, which are absolutely empty, or unpossessed by any thing whatever? If the *second*; then the doubt is to be stated thus: *An detur vacuum intra mundanum Coacervatum?* Whether within the World (for of the extramundane Inanity, the difficulty is not great, as may be collected from the contents of our *Second Chapter* præcedent) there can be any great or sensible Vacuity, such as we may imagine possible, if many of the small or interspersed Vacuities should convene and remain in one entire coacervate Inanity.

Art. 2. The nature of a *Disseminate* Vacuity, explained by the Analogy of a heap of Corn.

Concerning the *First* Problem, we cannot state the Doubt more intelligibly, then by proposing it under the analogy of this *Example*. Let a man intrude his hand into a heap of Corn, and his hand shall possess a certain sensible space among the separated Grains: his hand again withdrawn, that space doth not remain empty, but is immediately repossessed by the mutuall confluent grains, whose Confluxibility, not impeded, causeth

ſeth their inſtant convention. And yet betwixt the Grains mutually convened there remaine many intercepted or interpoſed Spaces or Intervalls, unpoſſeſsed by them; becauſe the Grains cannot touch each other ſo *ſecundum totas ſuperficies*, according to all parts of their ſuperficies, as to be contiguous in all points. Exactly thus, when any Body is intruded into Aer, Water, or any ſuch rare and porous nature, betwixt whoſe incontinued parts there are many Interſtices variouſly diſſeminated, it doth poſſeſs a certain ſenſible ſpace proportionate to its dimenſions: and when that Body is withdrawne, the ſpace cannot remain empty, becauſe the inſenſible or atomical particles of the Aer, Water, &c. agitated by their own native Confluxibility, inſtantly convene and repoſſeſs it. And yet, betwixt the convened particles, of which the Aer, and Water, and alſo all porous Bodies are compoſed, there remain many empty ſpaces (analogous to thoſe Intervalls betwixt the incontingent Grains of Corn) ſo minute or exiguous, as to be below the perception and commenſuration of ſenſe. Which is the very Difficulty, concerning which there are ſo many Controverſies extant, as their very Lecture would be a Curſe to the greateſt Patience. However, we conceive our ſelves ſufficiently armed with Arguments to become the Aſſertors of a *Vacuum Diſſeminatum*; or empty Intervals betwixt the particles of Rare, Porous, or Incontinued Bodies.

Art 3. The firſt *Argument* of a *Diſſeminate Vacuity*, deſumed from the evidence of *Motion*, in General: and *Ariſtotles* error concerning the Eſſence of *Place*, concifely detected, and corrected.

Our Firſt Argument is that Reaſon given for a Vacuum by *Epicurus*: Εἰ ὃ μὴ ἦν ὁ κενὸν, οὐκ ἂν εἶχε τὰ σώματα ὅπου ἦν, οὐδὲ δὶ ὧν ἐκινεῖτο, καθάπερ φαίνεται κινούμενα, *Niſi eſſet Inane, non haberent Corpora neque uti eſſent, neque quà motus ſuos obirent, cùm moveri ea quidem manifeſtum ſit:* Unleſs there were a Vacuum, Bodies could have neither where to conſiſt, nor whither to be moved; and manifeſt it is, that they are moved. Which ſolid Reaſon, though ſeemingly perſpicuous, hath in it ſo many receſſes of obſcurity, as may not only excuſe, but efflagitate a curſory paraphraſe. Firſt, we are to obſerve that, in the theory of *Epicurus*, the Notions of *Inanity* and *Locality* are one and the ſame *eſſentially*, but not *reſpectively*: *i.e.* that the ſame ſpace when repleniſhed with a Body, is a *Place*, but when devoid or deſtitute of any Tenent whatever, then it is a *Vacuum*. Secondly, that *Ariſtotle* did not ſufficiently profound the Quiddity of *Place*, when He taught, *that the Concave ſuperficies of the Circumambient did conſtitute the Eſſence thereof*. For, when it is generally conceded that the *Locus* muſt be adæquate to the *Locatum*; it is truly præſumed, that the internal ſuperficies of the Circumambient or Place, ought to be adæquate to the external ſuperficies of the Locatum or Placed; but not to its *Profundity*, or Internal Dimenſions. And, ſince it is of the formal reaſon of Place, that it be *Immoveable*, or uncapable of Tranſlation; for, otherwiſe any thing might, at one and the ſame time, be immote and yet change place: it is evident, that the ſuperficies of the Circumambient is not Immoveable, ſince it may both be moved, the Locatum remaining unmoved, and *è contrà*, perſiſt unmoved, when the Locatum is removed. And, therefore, the Concave ſuperficies of the Circumambient may, indeed, obtain the reaſon of a Veſſel, but not of a Place. And, upon conſequence, we conclude, that the *Space comprehended within the ſuperficies of the Circumambient*, is really and eſſentially what is to be underſtood by *Place* Since that Space is adæquated perfectly to its Locatum in all its internal Dimenſions, and is alſo truly Immoveable; in regard that upon the remove of the Locatum, it

it remains fixt, unchanged, unmoved; in the same state as before its occupation, it persevers after its desertion. And when the Body removed possesseth a new Space: the old Space is instantly possessed by a new Body. Thirdly, that this argument desumed from the Evidence of Motion, was proposed by *Empiricus*, (*adverſ. Geometr.*) more Syllogistically, thus, Ἐι ἔστι κίνησις, ἔστι κενὸν, ἀλλα μὴν ἔστι κίνησις, ἔστιν ἄρα κενόν. *Si Motus eſt, Inane eſt; atqui Motus eſt, eſt ergo Inane. If there be Motion, there muſt be Inanity; but Motion there is, therefore there is a Vacuum.*

Art. 4. Motion demonstrated by *Senſe*: and *Zeno's* ænigmatical Argument, for an Universal *Quiet*, diſſolved.

That there is Motion, is manifeſt from ſenſe. And as for that memorable Argument of *Zeno* againſt Motion, though we judge that he affected it more for the ſingularity, then ſolidity thereof, and only propoſed it as a new Paradox to gain ſome credit to Scepticiſm, of which he was a fierce Aſſertor; and that no man did ever admit it to a competition with the Authority of his Senſe: yet, ſince many have reputed it indiſſoluble, we conceive the ſolution thereof muſt become this place.

Motus non poteſt fieri per ſpatium quodvis, niſi prius mobile pertranſeat minus, quam majus; ſed quamcunque aſsignes partem, alia eſt minor, & alia minor in infinitum: Ergo non poteſt fieri motus, numquam enim incipiet. No Motion can be made through any ſpace whatever, unleſs the Moveable firſt paſs through a leſs, before a greater ſpace; but, what part of ſpace ſoever you ſhall pleaſe to aſſign, ſtill there will be another leſs part, and another leſs then that, and ſo up to infinity: therefore can there be no motion at all, ſince it can never begin at a ſpace ſo little as that no leſs can remain.

Solution.

The Fallacie lyeth in the *Minor*, which we concede to be true *ratione Mathematica*, in the Mathematical acceptation thereof; and ſo no ſolution can be ſatisfactory to the Argument, unleſs we admit an infinite Diviſibility in the parts of a Continuum: But deny it *ratione Phyſica*, in the proper Phyſical acceptation, and ſo we may ſolve the riddle by proving the parts of a Continuum not to be diviſible *ad infinitum*, and Motion is to be conſidered *penes realem rerum exiſtentiam.* Now, that Space is diviſible *ad infinitum* only *Extrinſecè* and *Mathematicè*, not *Phyſicè*, may be thus evinced. If Motion be diviſible *in infinitum*, the parts of a ſlow Motion will be as many as the parts of a ſwift Motion: but 'tis indubitate, that two parts of a ſwift motion are coexiſtent to one of a ſlow: therefore either that one part muſt be permanent, ſince it exiſteth in two times, or all Motions are equall in velocity and tardity, which is repugnant to experience. And *Motion*, *Space*, and *Time*, are perfectly Analogous, *i.e. Proportional*: for there is no part of Motion, to which there may not be aſſigned a Part of Space and Time fully reſpondent. Beſides, ſhould we allow the Argument to be too cloſe for the teeth of *Reaſon*; yet no man can affirm it to be too hard for the ſword of *Senſe*, and therefore it ought not to be reputed inextricable: ſince thoſe objects which fall under the ſincere judicature of the ſenſe, need no other Criterion to teſtifie their Verity. Upon which the judicious *Magnenus* happily reflected (*p.* 162.

Democriti

Democriti reviviſcent.) when He layed down this for a firm Principle: *Senſibilia per ſenſus ſunt judicanda, nam illius potentiæ eſt judicare de re, per quam res cognoſcitur; neque fides omnis ſenſibus deneganda.*

Art. 5. The *Conſequution* of the Argument (if no *Vacuum*, no *Motion*) illuſtrated.

This ſhort Excurſion ended, we revert to our *Fourth* obſervable, *viz.* the *Conſequution* or Inference of *Epicurus*, in his argument for a Vacuum: *If no Vacuum, no Motion.* Which ſeems both natural and evident; for what is full, cannot admit a ſecond tenent: otherwiſe nothing could prohibit the ſyntheſis or Coexiſtence of many Bodies in one and the ſame place; which to imagine, is the extremeſt Abſurdity imaginable.

For Illuſtration, let us Imagine, that the Uuniverſe (having nothing of Inanity interſperſed among its parts) is one Continued Maſs of Bodies ſo cloſely crouded, ramm'd, and wedged together, that it cannot receive any the leaſt thing imaginable more: and keeping to this Hypotheſis, we ſhall ſoon deprehend, whether any one Body among thoſe many diſpoſed within this compact or cloſely crouded Maſs may be removed out of its own to invade the place of another. Certainly, if all places be full, it muſt extrude another body out of its place, or become joint-tenant with it and poſſeſs one and the ſame place. Extrude a body out of its poſſeſſion it cannot, becauſe the Extruded muſt want a room to be received into; nor can the Extruded diſpoſſeſs a third, that third expel a fourth, that fourth eject a fifth, &c. Since the difficulty ſits equally heavy on all: and therefore, if the invaded doth not reſign to the invading, there can be no beginning of Motion, and conſequently no one Atome in the Univerſe can be moved. And, as for its becoming ſynthetical or joint-tenant, that is manifeſtly impoſſible: becauſe a Collocation of two Bodies in one and the ſame place, imports a reciprocal Penetration of Dimenſions, then which nothing can be more repugnant to the tenor of Nature: and therefore it remains, that every part of the Univerſe would be ſo firmly bound up and compacted by other parts, that to move thoſe Cochles, Snails, or Inſects, which are found in the ferruminated womb of Rocks, and incorporated to the heart of Flints, would be a far more modeſt attempt, then to move the leaſt atome therein.

Art. 6. An *Objection*, that the *Lococeſſion* of ſome Bodies, depends on their *Rarity* or *Poroſity*; not on a Diſſeminate Vacuity: prævented.

Nor can the *Diſſenting* evade the compulſion of this Dilemma, by prætending, that in the Univerſe are Bodies of *rare, porous*, and *fluxible* Conſtitutions, ſuch as are more adapted to Lococeſſion, or giving place upon their invaſion by other Bodies, then are Rocks or Flints. Becauſe, unleſs their *Rarity*, *Poroſity*, *Fluxibility*, or yeeldingneſs be ſuppoſed to proceed from *Inanity diſſeminate*; or, that all the particles of thoſe Bodies are contiguous, or munually contingent *ſecundum totas ſuperficies*: doubtleſs, they muſt be ſo Continued, as that it can make no difference, whether you call them Bodies of Flint or Aer. For, neither ſhall the Aer poſſeſs a place leſs abſolutely then a Flint: becauſe how many particles ſoever of place you ſhall ſuppoſe, no one of them can remain unpoſſeſſed; it being of the Eſſence of Place, that it be adæquate to its Tenent in all its internal Dimenſions, *i.e.* in the number and proportion of Particles: nor a Flint more perfectly then Aer, whoſe inſenſible Particles are præſumed to be reciprocally contingent in all points, and ſo to exclude all Interſperſed Inanity.

We

We said, *without Inanity interspersed, there can be no Beginning of Motion.* Which to explain, let us suppose that a Body, being to be moved through the Aer, doth in the first degree of motion propel the contiguous aer, the space of a hairs bredth, Now, the Universe being absolutely full, that small space of a hairs bredth must be præpossessed, and so the Body cannot be placed therein, untill it hath thence depelled the incumbent Aer. Nor can the contiguous Aer possessing that space of a hairs bredth be depelled *per latera* to a place behind: because that place also is replete with Aer. Insomuch, therefore, as the body to be moved, cannot progress through so small a space, as that of an hairs bredth, because of the defect of place for the reception of the Aer replenishing that space: it must of necessity remain bound up immoveably in that place, wherein it was first situate. But if we conceive the Aer to have small Inane *Vacuolas*, or Spaces (holding an analogy to those spaces interceding betwixt the Grains of a Heap of Corn or Sand) variously interposed among its minute insensible particles: then may we also conceive, how the Motion of a Body through the Aer is both begun and continued: *viz.* that the Body moved, doth by its superfice protrude the particles of the contiguous Aer, those protruded particles being received into the adjacent empty interstices, press upon the next vicine particles of aer, and likewise protrude them, which received also into other adjacent empty spaces become contiguous to, and urgent upon other next particles of Aer, and so forward untill, upon the successive continuation of the Compression by protrusion, and the consequent dereliction of a place behind, the lateral particles of the Aer, compressed by the anterior parts dissilient, are effused into it: and so, how much of Aer is compressed and impelled forward, so much recurrs backward *per latera*, and is dilated. The same also may be accommodated to the Lococession of the Parts of *Water*; allowing it this prærogative, that being propelled by a Body movent, it doth by its particles more easily propel the contiguous particles of the Aer, then its own; because the empty minute spaces of the aer incumbent upon the Water, are larger, which may be the reason, why water propelled forwards, becomes tumid and swelleth somewhat upwards in its superfice, and is depressed proportionately backward. Now according to this theory, ought we to understand the Reason of *Epicurus* for a Vacuum, desumed from the necessity of motion.

Art.7. No beginning of Motion, without Inanity interspersed.

SECT. II.

AS the nature of Motion considered in the General, hath afforded us our First Argument, for the comprobation of a Vacuity Disseminate: so likewise doth the nature of *Rarefaction* and *Condensation*, which is a species of Local Motion, speculated in particular, readily furnish us with a *Second.* Examine we therefore, with requisite scrutiny, some of the most eminent *Apparences* belonging to the *Expansion* and *Compression* of *Aer* and *Water*: that so we may explore, whether they can be salved more fully by our hypothesis of a Disseminate Vacuity, then by any other, relating to an Universal *Plenitude.*

Art.1. A second Argument of a Vacuity Disseminate, collected from the reason of *Rarefaction* and *Condensation.*

Art. 2. The eminent Phænomenon of an *Aerofclopet*, or *Wind-Gun*, solved by a Vacuity Disseminate among the incontiguous (*quoad totas superficies*) parts of aer.

Take we a *Pneumatique* or *Wind-Gun*, and let that part of the Tube, wherein the Aer to be compressed is included, be four inches long (the diameter of the bore or Cavity being supposed proportionate:) now if among the particles of that aer contained in the four inched space of the Tube, there be no empty Intervals, or minute Inanities; then of necessity must the mass of Aer included be exactly adæquate to the capacity or space of four inches, so as there cannot be the least particle of place, wherein is not a particle of aer æqual in dimensions to it, *i. e.* the number of the particles of aer is equal to the number of the particles of the Cavity. Suppose we then the number of particles common to both, to be 10000. This done, let the aer, by the Rammer artificially intruded, be compressed to the half of the space (not that the compression may not exceed that rate, for *Mersennus* (*in præf. ad Hydraulicam Pneumaticam Artem.*) hath by a most ingenious demonstration taught, that Aer is capable of Compression even to the tenth part of that space, which it possessed in the natural disposition, or open order of its insensible particles:) and then we demand, how that half space, *viz.* two inches, can receive the double proportion of Aer, since the particles of that half space are but 5000. Either we must grant that, before compression, each single particle of Aer possessed two particles of space, which is manifestly absurd: or, that after Compression, each single particle of space doth contain two of aer, which is also absurd, since two bodies cannot at once possess the same place: or else, that there were various Intervals Inane disseminate among the particles of Aer, and then solve the Phænomenon thus. As the Grains of Corn, or Granules of Sand, being powred into a vessel up to the brim, seem wholly to fill it, and yet by succussion of the vessel, or depression of the grains upon the imposition of a great weight, may be reduced into a far less space; because from a more lax and rare, they are brought to a more close and constipate congeries, or because they are reduced from an open, to a close order, their points and sides being more adapted for reciprocal contact *quoad totas superficies*, nor leaving such large Intervals betwixt them as before succussion or depression. So likewise are the particles of aer included in the four-inched space of the Tube, by Compression or Coangustation reduced downe to the impletion of onely the half of that space; because from a more lax or rare Contexture they are contracted into a more dense or close, their angles and sides being by that force more disposed for reciprocal Contingence, and leaving less Intervals, or empty spaces betwixt them then before.

Art. 3. Experiment of an *Æolipile*, or Hermetical Bellows, arresting a Vacuity Disseminate.

Our *Second* Experiment is that familiar one of an *Æolipile* which having one half of its Concavity replete with Water, and the other with Aer, and placed in a right position near the fire: if you will not allow any of the spaces within it to be empty, pray, when the Water by incalescence rarefied into vapours, issues out with thundering impetuosity through the slender perforation or exile outlet of its rostrum, successively for many hours together, how can the same Capacity still remain full? For, if before incalefaction the particles of Water and Aer were equal to the number of the particles of space contained therein; Pray, when so many parts both of Water and Aer, consociated

consociated in the form of a vapour, are evacuated through the Orifice, must not each of their remaining parts possess more parts of the capacity, and so be in many places at once? If not so, were there not, before the incalescence, many parts of Water and Aer crouded into one and the same part of space, and so a manifest penetration of real dimensions? Remains it not therefore more verisimilous, that, as an heap of dust dispersed by the Wind, is rarefied into a kind of cloud and possesseth a far larger space then before its dispersion; because the disgregated Granules of Dust intercept wider spaces of the ambient aer: so the remaining parts of Water and Aer in the cavity of the Æolipile possess all those Spaces left by the exhaled parts; because they intercept more ample empty Spaces, being disposed into a more lax and open contexture. And that this is caused by the particles of Fire, which intruding into, and with rapid impetuosity agitated every way betwixt the sides of the Æolipile, suffer not the parts of Aer and Water to quiesce, but disperse and impel them variously: so that the whole space seems constantly full by reason of the rapidity of the Motion.

Art. 4. Experiment of a *Sulphurate Tapor*, included in a Glass Vial, partly filled with Water: of the same importance.

The *Third* Mechanick Experiment, which may justifie the submission of our assent to this Paradox, is this. Having præpared a short Tapor of Wax and Sulphur grosly powdered, light and suspend it by a small Wier in a Glass Vial of proportionate reception, wherein is clean Fountain Water sufficient to possess a fifth part, or thereabout, of its capacity: and then with a Cork fitted exactly to the Orifice, stop the mouth of the Vial so closely, that the eruption of the most subtle Atom may be prevented. On this you shall perceive the flame and fume of the Sulphur and Wax instantly to diffuse and in a manner totally possess the room of the Aer, and so the fire to be extinguished: yet not that there doth succeed either any diminution of the Aer, since that is imprisoned, and all possibility of evasion præcluded; or any ascent of the Water, by an obscure motion in vulgar Physiology called *Suction*, since here is required no suction to supply a vacuity upon the destitution of aer. But if you open the orifice, and enlarge the imprisoned Aer, you shall then indeed manifestly observe a kind of obscure suction, and thereupon a gradual ascention of the Water: not that the flame doth immediately elevate the water, as well because it is extinct, and the water doth continue elevated for many hours after its extinction, as that, if the flame were continued, can it be imagined that it would with so much tenacity adhære to the tapor, as is requisite to the elevation of so great a weight of water; but rather, that upon the Coangustation or compression of the aer reduced to a very close order in the mutual contact of its insensible particles, the empty spaces formerly intercepted betwixt them being replenished with the exhalations of the tapor; when the orifice is deobturated, there sensibly succeeds a gradual expiration of the atoms of Fire, as the most agile, volatile and prepared for motion, and then the aer, impelled by its own native Fluxibility, re-expands or dilates it self by degrees. But since the narrowness of the Evaporatory, or orifice prohibits the so speedy reflexion or return of the compressed particles of the aer to their naturall contexture or open order, as the renitency of their fluxibility requireth, so long as there

remain any of the atoms of Fire in possession of their Vacuities, as long continues the reexpansion of the Aer; and that reexpansion pressing upon the sides of the water, causeth it to ascend, and continue elevated. And no longer, for so soon as the aer is returned to its native contexture, the water by degrees subsideth to the bottom, as before the accension of the Tapor: and so that motion commonly called a *Suction in avoidance of Vacuity*, is more properly a *Protrusion*, caused by the expanding particles of aer compressed.

Art 5. No *Combustible* in Aer: and so the opinion of the *Aristoteleans*, that the *Extinction of Flame imprisoned, is to be charged on the Defect of Aer, for its sustentation*; grosly erroneous.

If any præcipitous Curiosity shall recur to this Sanctuary, that in the Substance of the Aer is contained *Aliquid Combustibile*, some combustible matter, which the hungry activity of the flame of the Tapor doth prey upon, consume and adnihilate: He runs upon a double absurdity; (1) That in Nature is a substance, which upon the accidental admotion of Fire, is subject to absolute *Adnihilation*, which to suppose, smels of so great a wildness of Imagination as must justifie their sentence, who shall consign the Author of it to seven years diet on the roots of White Hellebor, nor durst any man but that *Elias Artium Helmont*, adventure on the publique Patronage of it. (2) That the Aer is the *Pabulum*, or Fewel of Fire: which though no private opinion, but passant even among the otherwise venerable Sectators of *Aristotle* (who unjustly refer the Extinction of flame imprisoned, to the *Defection of Aer*: as intimating that the destruction of Fire, like that of Animals doth proceed from the destitution of Aliment) is yet openly inconsistent to Reason and Experiment. To *Reason*, because the Aer, considered sincerely as Aer, without the admixture of vapours and exhalations, is a pure, simple and Homogeneous substance, whose parts are consimilar: not a composition of heterogeneous and dissimilar, whereof some should submit to the consumptive energie of Fire, and other some (of the invincible temper of Salamandes Wool, or Muscovy Glass,) conserve their originary integrity inviolable in the highest fury of the flames. Again, Themselves unanimously approve that Definition of *Galen* (*lib.*1. *de Element. cap.*1.) *Elementa sunt natura prima & simplicissima corpora, quæque in alia non amplius dissolvi queant*: that it is one of the essential Proprieties of an *Element* as to be ingenerable, so also *Indissoluble*: and as unanimously constitute the Aer to be an Element. To *Experiment*, because had the Fire found (and yet it is exceedingly inquisitive, especially when directed by Appetite, according to their supposition) any part of the Aer inflamable; the whole Element of aer had been long since kindled into an universal and inextinguable conflagration, upon the accension of the first focal fire: nor could a flash of Lightning or Gunpowder, be so soon extinct if the flame found any maintenance or sustentaculum in the Aer, but would enlarge it self into a Combustion more prodigious and destructive then that caused by the wild ambition of Phaeton. Most true it is, that Fire deprived of aer, doth suffer immediate extinction: yet not in respect of Aliment denyed (for *Nutrition* and *Vitality* are ever convertible) but of the *want of room* sufficient to contain its igneous and fuliginous Exhalations, which therefore recoiling back upon the flame, coarctate, suffocate, and so extinguish it. For upon the excessive and impetuous suddain afflation of aer, Flame doth instantly perish, though not imprisoned in a glass: the cause is, that the flame, not with tenacity sufficient adhæring to the body of the tapor, or lamp, is easily blown off, and being thus dislodged hath no longer subsistence in the aer. And Heat, beating upon the

the outſide or convex part of a Glaſs, ſeems ſenſibly to dilate the Aer impriſoned within; as is manifeſt upon the teſtimonie of all Thermometres, or Weather-Glaſſes, thoſe only which contain Chryſulca, or Aqua Fortis in ſtead of Water, at leaſt if the experiment be true, excepted: but Fire in the Concave or inſide of the Glaſs violently compreſſeth the aer, by reaſon of its fuliginous Emiſſions, which wanting vacuities enough in the aer for their reception, recoil and ſuffocate the fire.

Art. 6. A fourth ſingular and memorable *Experiment* of the Authors, of Yce at the noſe of a large Reverberatory Furnace, charged with *Ignis rotæ*; evidencing a Vacuity interſperſed in the Aer.

The *Fourth*, this. Being in an intenſe froſt at *Droitwich* in *Worceſterſhire*, and feeding my Curioſity with enquiring into the Mechanick operations of the *Wallers* (ſo the *Salt-boylers* are there called) I occaſionally took notice of *Yce*, of conſiderable thickneſs, in a hole of the earth, at the mouth of a Furnace very great and charged with a Reverberatory fire, or *Ignis rotæ*. Conſulting with my Phyloſophy, how ſo firm a congelation of Water could be made by Cold at the very noſe of ſo great a fire; I could light on no determination, wherein my reaſon thought it ſafe to acquieſce, but this. That the ambient Aer, ſurcharged with too great a cloud of exhalations from the fire, was forced to a violent receſſion or retreat, and a freſh ſupply of aer as violently came on to give place to the receding, and maintain the reception of freſh exhalations; and ſo a third, fourth and continued relief ſucceeded: and that by this continued and impetuous afflux, or ſtream of new aer, loaden with cold Atoms, the activity of the cold could not but be by ſo much the more intenſe at the mouth of the furnace, then abroad in the open aer, by how much the more violent the ſtream of cold aer was there then elſewhere. To complete and aſſure the Experiment, I cauſed two diſhes, of equal capacity, to be filled with river Water; placed one at the mouth of the furnace, the other *ſub Dio*: and found that near the furnace ſo nimbly creamed over with Yce, as if that viſibly-freezing Tramontane Wind, which the Italian calls *Chirocco*, had blown there, and much ſooner perfectly frozen then the other. And this I conceive to be alſo the reaſon of that impetuous ſuction of a ſtream of aer, and with it other light and ſpongy bodies, through the holes or pipes made in many Chimneys, to prævent the repercurſion of ſmoke.

From theſe obſervations equitably perpended and collated, our meditations adventured to infer

Art. 7. An *Inference* from that Experiment; that *Aer*, as to its General Deſtination, *is the Common Receptary of Exhalations.*

(1) That the Aer; as to its principal and moſt univerſal Deſtination was created to be the Ἀτμοδοχεῖον, or common RECEPTARY of Exhalations: and that for the ſatisfaction of this End, it doth of neceſſity contain a *Vacuum Deſſeminatum* in thoſe minute and inſenſible *Incontiguities* or Intervals betwixt its atomical Particles; ſince Nature never knew ſuch groſs improvidence, as to ordain an *End*, without the codeſtination of the *Means* requiſite to that End. To prævent the danger of miſconſtruction in this particular, we find our ſelves obliged to intimate; that in our aſsignation of this Function or Action to the Aer, we do not reſtrain the aer to this uſe alone: ſince Ignorance it ſelf cannot but obſerve it neceſſarily inſervient to the Conſervation of Animals endowed with the organs of Reſpiration, to the tranſvection of Light, the convoy of odours, ſounds, and all Species and Aporrhæas, &c. but that, in alluſion to that Diſtinction of Anatomiſts betwixt the *Action* and *Uſe* of a Part, we intend; that the grand and moſt General *Action* of the Aer, is the Reception or entertainment

entertainment of Vapours and Exhalations emitted from bodies situate in or near the Terraqueous Globe. And in this acception, allowing the Aer to be constituted the General *Host* to admit; we insinuate that it hath rooms wherein to lodge the arriving Exhalations: insomuch as the necessity of the one, doth import as absolute a necessity of the other: the existence of the *Final* ever attesting the existence of the Conductive, or *Mediatory* Cause.

Art. 8. A second Reason, that the *Aer* doth receive exhalations at a certain rate, or determinate proportion; which cannot be transcended without prodigious violence.

(2) That, though the Aer be variously interspersed with empty Interstices, or minute Incontiguities, for the reception of Exhalations: yet doth it receive them at a just *Rate*, *Tax*, or *determinate Proportion*, conform to its own Capacity, or *Extensibility*; which cannot without Reluctancy and Violence be exceeded. For when the Vacuities, or Holds have taken in their just portage, and equal fraught, the compressed aer hoyseth sail, bears off, and surrenders the Scene to the next adventient or vicine aer, which acteth the like part successively to the continuation of the motion. This may be exemplified in the experiment of the Furnace and Chimneys newly mentioned, but more manifestly in that of the *Sulphurate Taper* in the Vial: where the Aer, being overburthened with too great a conflux of fuliginous Exhalations, and its recession impeded by the stopping of the Vial, it immediately recontracteth it self, and in that renitency extinguisheth by suffocation the rude Flame, which oppressed it with too copious an afflux. As also in those of *Canons* and *Mines*; which could not produce such portentous effects, as are dayly observed in Wars, if it were not in this respect, that the Receptaries in the Aer suffer a rack or extension beyond their due Capacities. For, when the Powder fired in them is, in the smallest subdivision of time, so much subtiliated, as to yeeld a Flame (according to the compute of *Mersennus*) of 10000 parts larger in extension, then it self, while its Atoms remained in the close order and compact form of Powder; and the Aer, by reason of its imprisonment, is not able to recede, and bear off so speedily, as the velocity of the motion requires: for avoidance of a mutual Penetration of Dimensions among the minute particles of the Fire, smoke, and its own, it makes an eruption with so prodigious an impetuosity, as to shatter and evert all solid bodies situate within the orb of impediment.

Art. 9. The Existence of *Inane Incontiguities* in the Aer, confirmed by two considerable Arguments.

For the further Confirmation of our *First Thesis*, *viz.* That the Aer is interspersed with various Porosities, or Vacuities, by reason of the Incontiguity of its insensible Particles; and that these serve to the reception of all Exhalations: we shall superadd these two considerable Arguments. (1) If this *Vacuum Disseminatum* of the Aer be submoved, and an absolute Plenitude in the Universe from a Continuity of all its parts supposed: then must every the smallest motion, with dangerous violence run through the whole Engine of the World, by reason of that Continuity. (2) If the Aer were not endowed with such Porosities, other Bodies could never suffer the dilatation or rarefaction of themselves; since, upon the subtiliation or dilatation of their minute particles, *i. e.* the remove of their Atoms from a close to an open contexture, they possess 1000 times larger Capacities: and so there would be no room to entertain the continual *Effluviums*, expiring from all bodies passing their natural vicissitudes and degenerations.

SECT.

SECT. III.

TO these *Four* eminent *Experiments*, we might have annexed others numerous enough to have swelled this Chapter into a Volume; but conceiving them satisfactory to any moderate Curiosity, and that it can be no difficulty to a Physiological Meditation, to salve any *Apparence* of the same nature, by this *Hypothesis* of a *Vacuum Disseminatum* in the Aer, as the *Caussa sine qua non* of its *Rarefaction* and *Condensation*: we judged it more necessary to address to the discharge of the residue of our duty, *viz.* to præsent it as verisimilous; that in the *Water* also are variously dispersed the like *Vacuola*, or empty spaces, such as we have not unfitly compared to those διαστήματα, or *Intervals* betwixt the Granules of Sand in a heap, in those parts where their superficies are not contiguous, in respect of the ineptitude of their Figures for mutual contact in all points. And this seems to us so illustrious a Verity, as to require neither more attestation, nor explanation, then what this one singular Experiment imports.

Art. 1. That *Water* also contains *Vacuola*, empty Spaces; demonstrated.

'Tis generally known, that *Water* doth not dissolve *Salt* in an indefinite *quantity*, but *ad certam taxam*, to a certain determinate proportion; so as being once sated with the Tincture thereof, it leaves the overplus entire and undissolved. After a long and anxious scrutiny for a full solution of this *Phænomenon*, our thoughts happily fixed upon this: That, the Salt being in dissolution reduced (*Analysi retrograda*) into its most minute or Atomical Particles, there ought to be in the Water Consimilar or adæquate Spaces for their Reception; and that those Spaces being once replenished, the Dissolution (because the Reception) ceaseth. Not unlike to a full stomach, which eructates and disgorges all meats and drinks superingested: or full vessels, which admit no liquor affused above their brim. Hereupon, having first reflected upon this, that the Atomical Particles of common Salt are *Cubical*; and thereupon inferred, that, since the *Locus* must be perfectly adæquate to the *Locatum*, they could only fill those empty spaces in the water, which were also *Cubical*: we concluded it probable, that in the water there ought to be other empty spaces *Octohedrical*, *Sexangular*, *Spherical*, and of other Figures, which might receive the minute particles of other Salts, such as *Alum*, *Sal Ammoniac*, *Halinitre*, *Sugar*, &c. after their dissolution in the same Water. Nor did Experiment falsifie our Conjecture. For, injecting *Alum*, parcel after parcel, for many dayes together, into a vessel of Water formerly sated with the tincture of common Salt; we then, not without a pleasant admiration, observed that the Water dissolved the Alum as speedily, and in as great quantity, as if it altogether wanted the tincture of Salt; nor that alone, for it likewise dissolved no small quantities of other Salts also. Which is no obscure nor contemptible Evidence, that water doth contain various insensible *Loculaments*, *Chambers*, or *Receptaries* of different *Figures*: and that this variety of those Figures doth accommodate it to extract the *Tinctures* of several Bodies injected and infused therein. So as it is exceedingly difficult, to evince by Experiment that any Liquor is so sated with precedent Tinctures, as not to

Art. 2. From the Experiment of the Dissolution of *Alum*, *Halinitre*, *Sal Ammoniac*, and *Sugar*, in Water formerly sated with the Tincture of *Common Salt*

to be capable of others also: especially while we cannot arrive at the exact knowledge of the Figure of the Atomical Particles of the body to be infused, nor of the Figures of those minute spaces in the liquor, which remain unpossessed by the former dissolutions.

Art. 3. The verity of the Lord Bacons Assertion, that a repeated infusion of Rhubarb acquires as strong a vertue Cathartical, as a simple infusion of Scamony, in equal quantity: and why.

Upon which reason, we are bold to suspect the truth of the *Lord S. Albans* assertion; (*Centur.* 1. *Nat. Hist.*) *that by repeating the infusion of* Rhubarb *several times, letting each dose thereof remain in maceration but a small time (in regard to the Fineness and volatility of its Spirits, or Emanations) a medicament may be made as strongly Cathartical or Purgative, as a simple infusion of* Scamony *in the like weight.* For (1) when the empty spaces in the Menstruum, or Liquor, which respond in Figure to the Figure of the Atomical particles of the Rhubarb, are replenished with its Tincture; they can admit no greater fraught, but the Imbibition of Virtue ceaseth: and that two or three infusions, at most, suffice to the repletion of those respective spaces, may be collected from hence, that the Rhubarb of the fourth infusion loseth nothing of its Purgative Faculty thereby, but being taken out and singly infused in a proportionate quantity of the like liquor, it worketh as effectually as if it had never been infused before. (2) Experience testifieth the Contrary, *viz.* that a Drachm of Scamony singly infused in an ounce and half of White wine, doth operate (*cæteris paribus*) by 15 parts of 20, more smartly then 5 drachms of Rhubarb successively infused in the like quantity of the same or any other convenient Liquor.

Art. 4. Why two Drachms of Antimony impregnate a pint of Wine, with so strong a vomitory Faculty, as two ounces.

Here also is the most probable Cause, why two Drachms of *Antimony* crude, or *Crocus Metallorum*, give as powerful a Vomitory impregnation to a Pint of Sack, or White wine, as two ounces: *viz.* because the *menstruum* hath no more Vacuities of the same Figure with the Atomical *Effluviums* of the Antimony, then what suffice to the imbibition or admission of the two Drachms. For the Certitude of this, we appeal to the experience of a *Lady* in *Cheshire*, who seduced by an irregular Charity, and an opinion of her own skill, doth pretend to the cure of the sick, and to that purpose prepares her Catholique Vomitory, consisting of four Drachms and an half of crude *stibium* infused all night in 3 or 4 ounces of White wine, and usually gives it (without respect to the individual temperament of the *Assument* for one dose to the sick: and yet, as our selves have more then once observed, the infusion doth work with no greater violence, in some persons, then as much of our common *Emetique Infusion* prescribed in the reformed Dispensatory of our Venerable *College*. Nay more then this, our selves have often reduced the Dose of the same Emetique Infusion down only to 4 *Scruples*, and yet found its operation come not much short of the usual Dose of an *ounce*.

Art. 5. Why one and the same *Menstruum* may be enriched with various *Tinctures*.

Hence also may be desumed a satisfactory reason for the impregnation of one and the same *Menstruum* with various Tinctures: for Example, Why an Infusion of *Rhubarb*, sated with its tincture, doth afterward extract the tinctures of *Agarick*, *Senna*, the *Cordial Flowers*, *Cremor Tartari*, &c. injected according to the prescript of the judicious Physician, in order to his confection of a Compound Medicament requisite to the satisfaction of a *Complex Scope* or Intention.

Sect.

SECT. IV.

A *Third* Argument, for the comprobation of a *Vacuum Disseminatum*, may be adferred from the Cause of the Difference of Bodies in the degrees of *Gravity*, respective to their *Density* or *Rarity*, (*i. e.*) according to the greater or less Inane Spaces interspersed among their insensible Particles. And a *Fourth* likewise from the reason of the *Calefaction* of Bodies by the subingress or penetration of the Atoms of Fire into the empty Intervals variously disseminate among their minute particles. But, in respect that we conceive our *Thesis* sufficiently evinced by the *Præcedent Reasons*; and that the consideration of the *Causes* of *Gravity* and *Calefaction*, doth, according to the propriety of Method, belong to our succeeding Theory of *Qualities*: we may not in this place insist upon them.

Art. 1. Two other Arguments of a Vacuity Disseminate inferrible from (1) the difference of Bodies in the degrees of Gravity: (2) the Calefaction of Bodies by the penetration of igneous Atoms into them.

And as for those many *Experiments* of *Water-hour-glasses*, *Syringes*, *Glass Fountains*, *Cuppinglasses*, &c. by the inconvincible Assertors of the *Peripatetick Physiology* commonly objected to a *Vacuity*: we may expede them altogether in a word. We confess, those experiments do, indeed, demonstrate that Nature doth abhorr a *Vacuum Coacervatum*; as an heap of Sand abhors to admit an Empty Cavity great as a mans hand extracted from it: but not that it doth abhor that *Vacuum Disseminatum*, of which we have discoursed; nay, they rather demonstrate that Nature cannot well consist without these small empty Spaces interspersed among the insensible Particles of Bodies, as an heap of Sand cannot consist without those small Interstices betwixt its Granules, whose Figures prohibit their mutual contact in all points. So that our Assertion ought not to be condemned as a Kænodox inconsistent to the laws of Nature, while it imports no more then this; that, as the Granules of a heap of Sand mutually flow together to replenish that great Cavity, which the hand of a man by intrusion had made, and by extraction left, by reason of the *Confluxibility* of their Nature: so also do the Granules, or Atomical Particles of Aer, Water, and other Bodies of that *Rare* condition, flow together, by reason of the *Fluidity* or *Confluxibility* of their Nature, to prævent the creation and remanence of any considerable, or *Coacervate Vacuum* betwixt them. To instance in one of the *Experiments* objected. Water doth not distil from the upper into the lower part of a *Clepsydra*, or *Water-hour-glass*, so long as the Orifice above remains stopped; because all places both above and below are ful, nor can it descend until, upon unstopping the hole, the aer below can give place, as being then admitted to succeed into the room of the lateral aer, which also succeeds into the room of that which entered above at the orifice, as that succeeds into the room of the Water descending by drops, and so the motion is made by succession, and continued by a kind of Circulation. The same also may be accommodated to those Vessels, which *Gardners* use for the irrigation of their Plants, by opening the hole in the upper part thereof, making the water issue forth below in artificial rain.

Art. 2. The Experiments vulgarly adduced to prove no vacuity in nature, so far from denying, that they confess a Disseminate one.

Art. 3. The grand *Difficulty* of the Cause of the Aers restitution of it self to its natural contexture, after rarefaction and condensation; satisfied in brief.

It only remains, therefore, that we endeavour to solve that Giant *Difficulty*, proposed in defiance of our *Vacuum Disseminatum*, by the mighty

Merſennus (in Phænomen. Pneumatic. propoſ. 31.) thus. *Quomodo Vacuola, ſolitò majora in rarefactione, deſinant, aut minora facta in condenſatione creſcant iterum : quænam enim Elateria cogunt aerem ad ſui reſtitutionem?* How do thoſe Vacuities minute in the aer, when enlarged by rarefaction, recover their primitive exility; and when diminiſhed by condenſation, re-expand themſelves to their former dimenſions: What *Elaters* or *Springs* are in the aer, which may cauſe its ſuddain reſtitution to its natural conſtitution of inſenſible particles?

We *Anſwer*; that, as it is the moſt catholique Law of Nature, for every thing, ſo much as in it lies, to endeavour the conſervation of its originary ſtate; ſo, in particular, it is the eſſential quality of the Aer, that its minute particles conſerve their natural Contexture, and when forced in Rarefaction to a more open order, or in Condenſation to a more cloſe order, immediately upon the ceſſation of that expanding, or contracting violence, to reflect or reſtore themſelves to their due and natural contexture. Nor need the Aer have any Principle or Efficient of this Reflection, other then the *Fluidity* or *Confluxibility* of its Atomical Parts: the eſſence or *Quiddity* of which Quality, we muſt reſerve for its proper place, in our enſuing theory of Qualities.

CHAP.

CHAP. V.

A Vacuum Præternatural.

SECT. I.

BEsides a Natural, or Disseminate Vacuity frequently intercepted betwixt the incontiguous Particles of Bodies (the Argument of our immediately precedent Chapter) not a few of the highest form in the school of *Democritus* have adventured to affirm not only the possibility, but frequent introduction of a *Præternatural* or *Coacervate Inanity*: such as may familiarly be conceived, if we imagine many of those minute inane spaces congregated into one sensible void space. To assist this Paradox, the autoptical testimony of many Experiments hath been pleaded; especially of that *Glass Fountain* invented by *Hero* (*præf. in Spirit.*) and fully described by the learned and industrious *Turnebus* (*in lib. de calore*) and of that Brass Cylindre, whose concave carries an *Embolus*, or sucker of wood, concerning which the *subtle Galileo* hath no sparing discourse in the first of his *Dialogues*: but, above all, of that most eminent and generally ventilated one of a *Glass Cylindre*, or Tube filled with Quicksilver, and inverted; concerning which not long after the invention thereof by that worthy Geometrician, *Torricellius*, at Florence, have many excellent Physicomathematical Discourses been written by Monsieur *Petit*, Dr. *Paschal Mersennus*, *Gassendus*, *Stephanus Natalis*. Who, being all French, seemed unanimously to catch at the experiment, as a welcom opportunity to challenge all the Wits of Europe to an æmulous combat for the honour of perspicacity. Now albeit we are not yet fully convinced, that the chief Phænomenon in this illustrious Experiment doth clearly demonstrate the existence of a *Coacervate* Vacuity, such as is thereupon by many conceded, and with all possible subtlety defended by that miracle of natural Science, the incomparable *Mersennus* (*in reflexionib. Physicomathemat.*) yet, insomuch as it affords occasion of many rare and sublime speculations, whereof some cannot be solved either so fully, or perspicuously by any Hypothesis, as that of a *Vacuum Disseminatum* among the insensible particles of Aer and Water; and most promise the pleasure of Novelty, if not the profit of satisfaction to the worthy considerer; we judge it no unpardonable Digression, here to present to our judicious Reader, a faithful Transcript of the Experiment, together with the most rational solutions of all the

Art. I. What is conceived by a *Coacervate Vacuity*: and who was the *Inventor* of the famous Experiment of *Quicksilver* in a *Glass Tube*, upon which many modern Physiologists have erected their perswasion of the possibility of introducing it.

Experientiam apponam, cujus inventionem etsi nescio qui alii ambitiosius sibi arrogent; certò tamen mihi constat, primum à Torricellio, *nobili magni Ducis Æ'truriæ Mathematico detectam, &c.* Athanas Kircherus, in Artis magn. Consoni & Dissoni l. 1. p. 11. in singulari Digressione

the admirable Apparences obſerved therein, firſt by *Torricellius* and the reſt beyond Sea, and ſince more then once by our ſelves.

The Experiment.

Art. 2. A faithful deſcription of the *Experiment*, and all its rare *Phænomena*.

Having prepared a Glaſs Tube (whoſe longitude is 4 feet, and the diameter of its concavity equal to that of a mans middle finger) and ſtopped up one of its extremities, or ends, with a ſeal Hermetical: fill it with Quickſilver, and ſtop the other extreme with your middle finger. Then, having with a moſt ſlow and gentle motion (leſt otherwiſe the great weight of the Quickſilver break it) inverted the Tube, immerge the extreme ſtopt by your finger into a Veſſel filled with equal parts of Quickſilver and Water, not withdrawing your finger untill the end of the Tube be at leaſt 3 or 4 inches deep in the ſubjacent Quickſilver: for, ſo you prævent all inſinuation or intruſion of Aer. This done, and the Tube fixed in an erect or perpendicular poſition; upon the ſubduction of your finger from the lower orifice, you may obſerve part of the Quickſilver contained in the Tube to deſcend ſpeedily into the reſtagnant or ſubjacent Quickſilver, leaving a certain ſpace in the ſuperior part of the Tube, according to apparence at leaſt, abſolutely Void or Empty: and part thereof (after ſome Reciprocations or Vibrations) to remain ſtill in the Tube, and poſſeſs its cavity to a certain proportion, or altitude of 27 digits, or 2 feet, 3 digits and an half (proximè) conſtantly. Further, if you recline, with a gentle motion alſo, the upper extreme of the Tube, untill the lower, formerly immerſed in the Quickſilver, ariſe up into the region of the Water incumbent on the ſurface of the Quickſilver: you may perceive the Quickſilver remaining in the Tube to aſcend by ſenſible degrees up to the ſuperior extreme thereof, together with part of the Water; both thoſe liquors to be confounded together; and, at length, the Quickſilver wholly to diſtill down in parcels, ſurrendring the cavity of the Tube to the poſſeſsion of the Water. Likewiſe, if you recline the ſuperior extreme of the Tube, untill its altitude reſpond to that of 27 digits, ſtill retaining the oppoſite extreme in the region of the ſubjacent Quickſilver in the veſſel: then will the Quickſilver be ſenſibly impelled up again into the Tube, untill that ſpace formerly vacated be repleniſhed. Finally, if, when the Quickſilver hath fallen down to the altitude of 27 digits, the Tube be ſuddainly educed out of the ſubjacent Quickſilver and Water, ſo as to arrive at the confines of the Aer; then doth the Aer ruſh into the Tube below, with ſuch impetuoſity, as to elevate the Quickſilver and Water contained in the Tube, to the top; nay, to blow up the ſealed end thereof, and drive out the liquors 4 or 5 feet perpendicular up in the aer; not without ſome terror, though not much danger to the Experimentator, eſpecially if he do not expect it.

Now though it be here præſcribed, that the Tube ought to be 4 feet in length, and the amplitude of its Cavity equal to that of an ordinary mans finger: yet is neither of theſe neceſſary; For, whatever be the longitude, and whatever the amplitude of the Tube, ſtill doth the Quickſilver, after various reciprocations, acquieſce and ſubſiſt at the ſame ſtandard of 27 digits; As Dr. *Paſchal* junior found by experience in his Tube 15 feet long, which he bound to a ſpear of the ſame length, ſo to prevent the fraction thereof, when it was erected perpendicularly, replete with Quickſilver, (*in libro cui titulus, Experiences Novelles touchant le Vuide.*)

Among

Among those many (*Natalis* reckons up no less then 20) stupendious Magnalities, or rare *Effects*, which this eminent Experiment exhibits to observation; the least whereof seems to require a second *Oedipus* more perspicacious then the first, for the accommodation thereof though but to plausible and verisimilous Causes, and might had *Aristotle* known it, have been reputed the ground of his despair, with more credit then that petty Problem of the frequent and irregular Reciprocation of *Euripus*: we have selected only *six*, as the most considerable, and such whose solution may serve as a bright tapor to illuminate the reason of the Curious, who desire to look into the dark and abstruce *Dihoties* of the rest.

Art. 3. The Authors, reason, for his selection of only *six* of the most considerable *Phænomena* to explore the *Causes* of them.

SECT. II.

The First Capital Difficulty.

Art. 1. The First Cardinal Difficulty.

WHether that Space in the Tube, betwixt the upper extreme thereof and the Quicksilver delapsed to the altitude only of 27 digits, be really an entire and absolute Vacuity?

Concerning this, some there are who confidently affirm the space between the superfice of the Quicksilver defluxed and the superior extreme of the Tube, to be an absolute COACERVATE VACUITIE: such as may be conceived, if we imagine some certain space in the world to be, by Divine or miraculous means, so exhausted of all matter or body, as to prohibit any corporeal transflux through the same. And the *Reasons*, upon which they erect their opinion, are these subsequent.

Art. 3. The Desert space in the Tube argued to be an absolute *Vacuum coacervate*, from the impossibility of its repletion with *Aer*.

This space, if possessed by any Tenent, must be replenished either with common *Aer*, or with a more pure and subtle substance called *Æther*, which some have imagined to be the Universal *Cament* or common *Elater*, by which a general Continuity is maintained through all parts of the Universe, and by which any Vacuity is prævented: or by some *exhalation* from the mass of Quicksilver included in the Tube.

First, that it is not possessed by *Aer*, is manifest from several strong and convincing reasons.

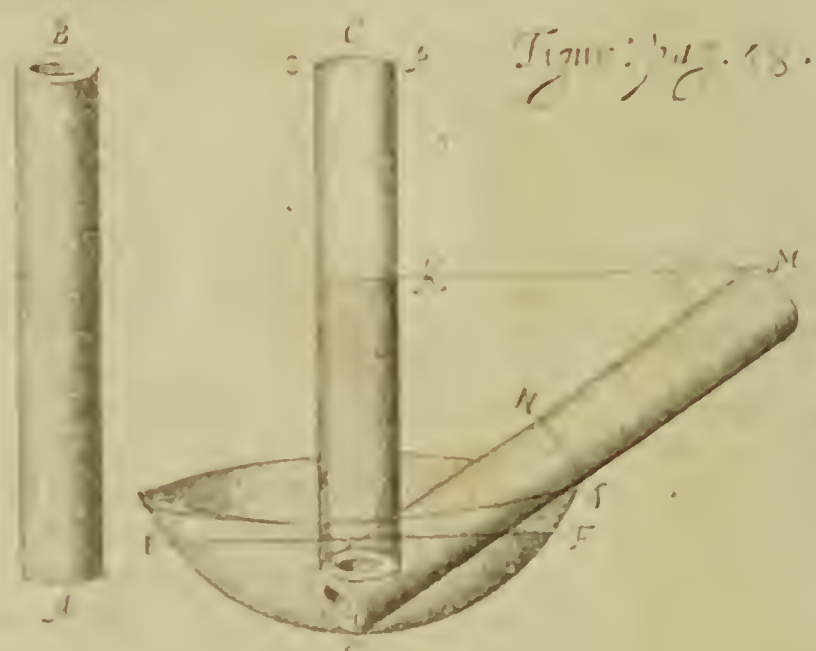
(1) Because the inferior end of the Tube, *D*, is so immersed into the subjacent mass of Quicksilver below the line *E F*, that no particle of aer can enter thereat.

(2) Because, if there were aer in the Tube filling the deserted space *C K*, then would not the circumambient or extrinsecal aer, when the Tube is educed out of the restagnant Quicksilver, and Water, rush in with that violence, as to elevate the remainder of the Quicksilver in the Tube, from *K* to *D*, up to the top *C*, and break it open; as is observed: in regard, that could not happen without a penetration of bodies. So that, if we suppose any portion of aer to have slipped into the Tube below, at the subduction of the finger that closed the orifice: then would not the Mercury reascending (upon the

the inclination of the Tube down to the horizontal line *K M*,) rise up quite to the top *C*, but subsist at *O P*. But the contrary is found upon the experiment.

(3) When the Tube, after the deflux of the Mercury to *K*, is reclined so as the extreme *C*, be of the same horizontal altitude with the point *K*, as is visible in the Tube *L M*: then doth the Mercury in the subject vessel reascend into the same, and again possess the desert Space *K C*, or *N M*. This being so, Whither can the aer, if any the least portion of it were resident in the space *N M*, retreat, since the extreme *M*, is hermetically closed, and so no way for its egression can be prætended.

Art. 4. The Experiment prasented in *Icenisim.*



A B, *A Tube of Glass, replete with Quicksilver.*

A, *The lower extreme thereof, hermetically sealed.*

B, *The upper extreme thereof; open.*

D C, *The same Tube inverted, and perpendicularly erected in a vessel full of Quicksilver: so as the orifice* D, *be not unstopped, untill it be immersed in the subjacent Quicksilver.*

H G I, *A vessel filled up to the line* E F, *with Quicksilver: and thence up to the brim* H I, *with Water.*

C K, *The Vacuum, or Space deserted by the Quicksilver descended*

O C P, *The quantity of Aer supposed to have insinuated it self at the subduction of the finger from the inferior orifice* D.

K M, *A Line parallel to the Horizon.*

L M, *The same Tube again filled with Quicksilver, and reclined untill the upper extreme thereof become parallel to the same horizontal altitude with* K.

N, *The distance of* 27 *inches from* L, *as* K *from* D.

(4) If any portion of Aer chance to intrude into the cavity of the Tube; which may come to pass either if, when the superior orifice of the Tube is inverted, it be not exactly obturated by the finger of the Experimentator; or, if at the extraction of his finger the lower extreme be not immersed deep enough in the subjacent Mercury, to prevent the subingress of some aer; or, if the orifice of the Tube

Tube educed out of the region of the ſubjacent Mercury and Water, be not wholly deobturated at once, but ſo as there is only ſome ſlender inlet of Aer: We ſay, if in any of theſe Caſes it happen, that ſome ſmall portion of aer be admitted into the cavity of the Tube; we have the evidence of our ſenſe, and the moſt infallible one too, that the aer ſo admitted doth not aſcend to the top *C*, but remaine viſible in certain ſmall Bubbles (ſuch as uſually mount up to the ſurface of ſeething water) immediately upon the ſuperfice of the Mercury at the altitude of 27 digits *K*. As if, indeed, the aer were attracted, and in a manner chained down by the *Magnetical Effluviums* of the earth, together with the pendent Quickſilver: which having more *Anſulæ* or *Faſtnings*, whereon the ſmall Hooks of the Magnetical Chains exhaling from the Globe of the Earth, may be accommodately fixed, is therefore attracted downward more forcibly, and, in that reſpect, is reputed to have the greater proportion of *Gravity*. Again, If upon the inclination of the Tube, and the ſucceeding repletion of the ſame by the regurgitating Mercury, that portion of aer formerly entered be propelled up to the top of the Tube, *C*; and then the Tube again reduced to its perpendicular, ſo as the Quickſilver again deflux to *K*: in this caſe the aer doth not remain at *C*, but ſinks down as formerly to *K* alſo, and there remains incumbent upon the face of the Quickſilver. Which Deſcent of the aer cannot be more probably referred to any Cauſe, then the Attraction of the Magnetick ſtreams of the Earth.

(5) Having admitted ſome few Bubbles of aer to ſlide up by the margine of the Mercury into the deſert Space *K C*; and then reclined the Tube to the altitude of the horizontal line *K M*: you may perceive the delapſed Quickſilver not to be repelled up again quite to the top, as before the irreption of aer, but to make a ſtand when it arrives at the confines of the included aer at *O P*, leaving ſo much ſpace, as is requiſite for the reception of it. Nor can it do otherwiſe, without a penetration of Dimenſions, by the location of two Bodies in one and the ſame place.

(6) Moreover, after the acquieſcence of the Quickſilver at *K*, if you ſtop the inferior extreme *D*, with your finger, while it remains immerſed in the reſtagnant Quickſilver *E F*, ſo as to præclude the irreption of any more aer; and then invert the Tube again: the Scene of the Deſert Capacity *C K*, will be changed to the contrary extreme ſtopt by your finger, and yet without the leaſt ſign of aer pervading the maſs of Quickſilver in a kind of ſmall ſtream of Bubbles, contrary to what evene's, when aer is admitted into the Tube in a ſmall quantity, for in that caſe, upon the inverſion of the Tube, you may plainly behold an interſection between the deſcending Quickſilver and the aſcending aer, which mounts up through it in a ſmall ſtream or thread of Bubbles.

(7) To thoſe, who conceive that a certain portion of the *Circumſtant* Aer, being forced by the compreſſion of the reſtagnant Mercury in the Veſſel, riſing higher, upon the deflux of the Mercury contained in the Tube, doth penetrate the ſides of the Tube, and ſo repleniſh the deſert Capacity therein: we anſwer; that though we deny not but aer may penetrate the pores or Incontiguities of Glaſs, ſince that is demonſtrable in Weather Glaſſes, and in the experiment of

Sir *Kenelm*

Sr. *Kenelm Digby*, of making a ſenſible tranſudation of Mercury mixt with Aqua Fortis in a Bolt-head, through the ſides thereof, if gently confricated with a Hares-foot on the outſide; yet cannot it be made out, that therefore the Deſert Capacity in the Tube is poſſeſſed with Aër, for two inoppugnable reaſons. (1) Becauſe though the Tube be made of Braſs, Steel, or any other Metal, whoſe conteꝛture is ſo cloſe, as to exclude the ſubtleſt aer, yet ſhall the Experiment hold the ſame in all Apparences, and particularly in this of the deflux of the Quickſilver to the altitude of 27 digits. (2) Becauſe, if the deſert Cavity were replete with aer; the incumbent aer could not ruſh in to the Tube, at the eduction of its lower end *D*, out of the reſtagnant Mercury and Water, with ſuch violence; ſince no other cauſe can be aſſigned for its impetuous ruſhing into the Tube, but the regreſſion of the compreſſed parts of the ambient aer to their natural laxity, and to the repletion of the violent or forced Vacuity. Since, if the whole Space in the Tube were poſſeſſed, *i.e.* if there were as many particles of Body, as Space therein: doubtleſs, no part of place could remain for the reception of the irruent aer.

Art. 5. The Vacuity in the Deſert Space, not prævented by the inſinuation of *Æther*.

Secondly, As for that moſt ſubtile and generally penetatrive ſubſtance, *ÆTHER*, or pure Elementary Fire, which ſome have imagined univerſally diffuſed through the vaſt Body of Nature principally for the maintenance of a Continuity betwixt the parts thereof, and ſo the avoidance of any Vacuity, though ne're ſo exile and minute; we do not find our ſelves any way obliged to admit, that the *Deſert Space* in the Tube is repleted with the ſame, untill the *Propugnators* of that opinion ſhall have abandoned their Fallacy, *Petitio principii*, a præcarious aſſumption of what remains dubious and worthy a ſerious diſpute, *viz. That Nature doth irreconcileably abhor all vacuity, per ſe.* For, until they have evinced beyond controverſie, that Nature doth not endure any Emptineſs or ſolution of Continuity, *quatenus* an *Emptineſs*, and not meerly *ex Accidenti*, upon ſome other ſiniſter and remote reſpect: their Poſition, that ſhe provided that ſubtile ſubſtance, *Æther*, chiefly to prevent any Emptineſs, is raſhly and boldly anticipated, and depends on the favour of Credulity for a toleration. Nor is it ſo ſoon demonſtrated, as affirmed, that all Vacuity is repugnant to the fundamental conſtitution of Nature.

Art. 6. A Paradox, that Nature doth not abhor all vacuity, *per ſe*; but only *ex Accidenti*, or in reſpect to *Fluxility*.

Naturam abhorrere Vacuum, is indeed, a maxim, and a true one: but not to be underſtood in any other then a *metaphorical* ſenſe. For, as every Animal, by the inſtinct of ſelf-conſervation, abhors the ſolution of Continuity in his ſkin, cauſed by any puncture, wound, or laceration; though it be no offence to him to have his ſkin pinkt or perforated all over with inſenſible pores: ſo alſo by the indulgence of a Metaphor, may Nature be ſaid to abhor any great or ſenſible vacuity, or ſolution of Continuity, ſuch as is imagined in the Deſert Space of the Tube; though it be familiar, nay uſeful and grateful to her, to admit thoſe inſenſible inanities, or minute poroſities, which conſtitute a *Vacuum Diſſeminatum*. We ſay, by the *indulgence of a Metaphor*; becauſe we import a kind of *ſenſe* in Nature, analogous to that of Animals. And, tollerating this Metaphorical Speech, that Nature hath a kind of ſenſe like that of Animals; yet, if we allow for the vaſtity of her Body can it be conceived no greater

greater trouble or offence to her, to admit such a solution of Continuity, or Emptiness, as this supposed in the Desert space of the Tube, then to an Animal, to have any one pore in his skin more then ordinarily relaxed and expanded for the transudation of a drop of sweat. This perpended, it can seem no *Antiaxiomatisme*, to affirm, that nature doth not abhor Vacuity, *per se*, but onely *ex Accidenti*: i. e. upon this respect, that in Nature is somewhat, for whose sake she doth not, without some reluctany, admit a Coacervate or sensible Vacuity. Now that somewhat existent in Nature *per se*, in relation to which, she seems to oppose and decline any sensible Vacuity, can be no other then the *Fluxility* of her Atomical Particles, especially those of *Fire*, *Air*, and *Water*. And, for ought we poor Haggard Mortals do, or can, by the Light of Nature, know to the contrary, all those vast spaces from the margent of the Atmosphere, whose altitude exceeds not 40 miles (according to *Mersennus* and *Gassendus*) perpendicular, up to the Region of the fixed Stars; are not only Fluid, but *Inane*; abating only those points, which are pervaded by the rayes of the Sun and other Celestial Bodies. But, why should we lead the thoughts of our Reader up to remote objects, whose sublimity proclaims their incertitude; when from hence only, that the Aer is a *Fluid* substance: it is a manifest, direct and unstrained consequence, that the immediate cause of its avoidance of any sensible or coacervate Vacuity, is the Confluxibility of its Atomical particles; which being in their natural contexture contiguous in some, though not all points of their superficies, must of necessity press or bear each upon other, and so mutually compel each other, that no one particle can be removed out of its place, but instantly another succeeds and possesses it; and so there can be no place left empty, as hath been frequently explained by the simile of a heap of Sand? Now, if the Confluxibility of the insensible particles of the aer, be the immediate and *per se* Cause of its avoidance of any aggregate sensible solution of Continuity: we need no farther justification of our position, that Nature doth oppose vacuity sensible not *per se*, but only in order to the affection of Confluxibility, *i. e. ex Accidenti*

Art. 7. A second Argument against the repletion of the Desert space by *Æther*

Again, should we swallow this præcarious supposition of the *Æther*, with no less pertinacity, then ingenuity asserted by many Moderns, but professedly by *Natalis*, in both his Treatises (*Physica Vetus & Nova, & Plenum experimentis novis confirmatum*) and admit, that Nature provided that most tenuious and fluid substance chiefly to prævent Vacuity: yet cannot the Appetite of our Curiosity be satisfied, that the Desert space in the tube is replenished with the same, prenetrating through the glass; untill they have solved that Apparence of the violent irruption of the ambient Aer into the orifice of the tube, so soon as it is educed out of the subjacent liquors, the Quicksilver and Water, by the same Hypothesis. Which whether they have done, so as to demonstrate, that the sole cause of the Aers impetuous rushing into the canale of the Tube, and prodigiously elevating the ponderous bodies of Quicksilver and Water residuous therein, is not the Reflux of the incumbent aer, by the ascention of the restagnant Quicksilver in the vessel, compressed to too deep and diffused a subingression of its insensible Particles, to recover its natural laxity, by regaining those spaces, from which it was expelled and secluded; and to supply the defect of this reason, by substituting some other syntaxical to their hypothesis of the Æther, which shall

be more verisimilous and plausible: this we ought to refer to the judgment of those, who have attentively and æquitably perused their Writings.

Art. 8. The Vacuity of the Desert space, not prævented by an *Halitus*, or *Spiritual Efflux* from the Mercury: for three convincing reasons.

Lastly, as for the third thing supposed to replenish the Desert space in the Tube, *viz.* A certain spiritual *Efflux*, or *Halitus*, in this exigent, educed out of the Mass of Quicksilver, by a secret force of Nature, which makes any shift to avoyd that horrid enemy of hers, Inanity; we deny not the possibility of extracting or exhaling a spiritual substance from Quicksilver, fine enough to possess such a space, without obnubilating it: but cannot conceive in this case, what should be the efficient of that Extraction; for who can acquiess in that General, *a secret Force of Nature?* (2) What becomes of that Exhalation, when the Tube, meerly upon its reclination to the altitude of the Horizontal line, *K. M.* is repossessed with Mercury; for, to admit its reduction to what it was before separation, is to suppose a second secret force in Nature syncritical, or Conjunctive, Antagonist to the former Diacritical or Separative, which operateth without Heat, as the other without Cold: and to admit, its expiration through the pores or incontiguities of the Glass, is either to suppose the same portion of Quicksilver rich enough in spirit to replenish that Desert space a thousand times successively, in case the Tube be so often elevated and reclined; for if all the spiritual substance be once exhausted, then must that Fox, Nature, recur to another expedient, or else tollerate a vacuity Coacervate; or to suppose that the same exhalation doth again return into the Glass, by the same slender ways it expired, which is a Fancy worthy the smile of *Heraclitus*. (3) How this *Halitus*, in respect it is præsumed more rare and subtile, then the aer admittible by the orifice of the Tube, upon its reseration, can consist without *Inanity Disseminate*: which implicateth an Universal Plenitude.

And these are the *Reasons*, which at first inclined our judgement to determine on their part, who opinion the *Desert space* in the Tube to be an absolute *Coacervate Vacuity*.

Art. 9. The *Authors* Apostacy from the opinion of an absolute Coacervate Vacuity in the desert space: in regard of

But, it was not long, before our second and more circumspect cogitations, assisted by time, which insensibly delivered our mind from that pleasant enchantment of novel conceptions, and reduced it to that just temper of indifferency, requisite to sincere discernment and æquitable arbitration; perpending also the Arguments impugning the former perswasion of a Coacervate Vacuity, and diminishing it down onely to a *Disseminate* one in the Desert space of the Tube: found them, by incomparable excesses, to preponderate the former, and with many more grains or moments of Verisimilty to counterpoyse our judgement to their end of the balance. And the Arguments Negative, are these.

Art. 10. The possibili- of the subingression of light.

(1) Manifest it is even to the most critical of our senses, that LIGH Tpenetrating the sides of the Glass Tube, doth totally pervade the Desert Space: therefore it cannot be an absolute sensible Vacuum. Now, that Light is a Body, or that the rayes of Light are certain Corporeal, though most minute Effluviums transmitted from the luminous Body, or Focus; is a Truth so universally embraced by all Knowing men, and upon such apodictical commendations, that here to demonstrate it, would not only be an unseasonable Digression, but a criminal Parergy.

(2) Though

(2) Though the Tube might be made of ſome metal, or other material, whoſe contexture of Atomical Particles is ſo denſe and compact, as not to permit the trajection of the beams of Light; and though the Experiment would be the ſame, in all Apparences, if made in the dark: yet may the Deſert Space be poſſeſſed by the ſubtle *Atoms* of *Heat*, or *Cold*, proceeding from the ambient aer, and inſinuating themſelves through the incontiguities of the Tube. That the Atoms of Heat and Cold ordinarily transfix Glaſs, is evident from the Experience of Weather-glaſſes: in which the cauſe of the deſcent of the Water included, is the Rarefaction of the aer therein by the Heat, and the cauſe of the aſcent of the water in cold Weather, is the Condenſation of the ſame aer by Cold; neither of which were poſſible, if the ſubingreſſion of Cold and Hot Atoms through the Glaſs were excluded. And, that the aer incarcerated in a Thermometre, or Temperamental organ of Silver, Coper, or Braſs, is ſubject to the ſame mutations of qualities, upon the ſame viciſſitude of Cauſes: hath been ſo frequently experimented, as to cut off all prætext of diffidence. Which is alſo a ſufficient manifeſt, that the Atoms of Heat and Cold are more exile and penetrative, then thoſe of the common Aer of uſe to Animals in Reſpiration: inſomuch as they inſinuate themſelves through ſuch bodies, whoſe almoſt continued parts interdict the intruſion of the groſſer particles of Aer, which cannot permeate through ordinary Glaſs. (1) Becauſe, if you ſhut your ſelf in a cloſet, or chamber, that hath but one ſmall window conſiſting of one entire pane of Glaſs, and that ſo cæmented into Lead, as that no chinke is left between; and whoſe cranies as well in the door, as elſewhere are all damm'd up: you cannot hear the voice of another perſon, though ſpeaking very loud and near the Glaſs on the outſide, notwithſtanding you lay your ear cloſe thereunto. Now, ſince a *Sound* (at leaſt the *Vehicle* of a ſound) can be nought elſe, but a ſubtle portion of the aer modified; as ſhall be profeſſedly commonſtrated, when time hath brought us ſo far on our præſent journey, as the proper place for our Enquiry into the Nature of Sounds: and yet this ſo ſubtle and fine a portion of the aer cannot penetrate Glaſs of an ordinary thickneſs: we have the auctority of no weak nor obſcure Reaſon, to countenance this our Conjecture, that the Atoms of Cold and Heat, are more exile and ſearching, then the common Aer. (2) If you include ſmall Fiſhes in a large vial of the thinneſt Glaſs, filled with River water; they may live therein for many months, provided the orifice of the Glaſs remain open and free to the aer: but, if you once ſtop it, ſo as to exclude the aer, they ſhall expire in few moments. Whence we may conclude, that however Fiſhes ſeem to have an obſcure kind of Reſpiration, ſuch as may be ſatisfied with that ſmall portion of Aer, which is commixt with Water: yet is not that thin and ſubtile aer, ſuppoſed to penetrate Glaſs, the ſame they (or any other Animal) uſe in Reſpiration. Which had thoſe grand Maſters of myſterious Diſquiſitions, *Merſennus* and *Robervallius* animadverted; they might have ſoon divined, what would be the event of their intended Experiment, of including ſome ſmall Animal, as a Mouſe or Graſhopper, in a Glaſs of ſufficient capacity, and luting on the ſame on the top of the Tube, where the Deſert Space uſeth to be, in the Experiment of Mercury, ſo to try whether the vital organs thereof could keep on their motions in a place devoid of aer: inſomuch as that purer ſubſtance diminant from the region of the circumjacent Aer, is not corporeal enough to ſerve the neceſſity of Reſpiration in any Animal, though ne're ſo minute. The manner of

Art. 2. Of the Atoms or inſenſible bodies of *Heat* and *Cold*: which are much more exile and penetrative then common Aer.

making this Experiment, is, by *Mersennus (p.50. reflect. physicomathemat.)* præscript, thus: *Porro, operæ prætium foret aliquam muscam admodum vegetam & robustam, v.c. Crabronem, aut Vespam, in tubo includere, priusquam Mercurio impleretur, ut post depletionem ad altitudinem 27 digit. proximè, videretur num in eo Vacuo, aut, si mavis, æthere viveret, ambularet, volaret, & num Bombus à volante produceretur.*

Art. 12. Of the *Magnetical Efflux* of the *Earth*: to which opinion the Author resigns his *Assent.*

(3) Deducting the possibility of both these, there yet remains a *Third* substance, which may well be conceived to prævent a Coacervate Vacuity in the forsaken space of the Tube: and that's the MAGNETICAL EFFLUX of the Earth. For (1) that the Terraqueous Globe is one great *Magnet*, from all points of whose superfice are unceſſantly deradiated continued Threads or beams of subtle insensible *Aporrhæa's*, by the intercession whereof all Bodies, whose Descent is commonly adscribed to Gravity, are attracted towards its Centre; in like manner as there are continually expired from the body of the Loadstone invisible Chains, by the intercession whereof Iron is nimbly allected unto it: is so generally conceded a position among the Moderns, and with so solid reasons evicted by *Gilbert*, *Kircher*, *Cartesius*, *Gassendus* and others, who have professedly made disquisitions and discourses on that subject; that we need not here retard our course, by insisting on the probation thereof.

(2) That, as the Magnetical expirations of the Loadstone, are so subtle and penetrative, as in an instant to transfix and shoot through the most solid and compact bodies, as Marble, Iron, *&c.* without impediment; as is demonstrable to sense, the interposition of what solid body soever, situate within the orb of energy, in no wise impeding the vertical or polory impregnation of a steel Needle by a Magnet loricated, or armed: so also the Magnetical Effluvias of the Globe of Earth do pervade and pass through the mass of Quicksilver contained both in the Tube, and the Vessel beneath it, and fixing their Uncinulæ or hamous points, on the Ansulæ, or Fastnings of the Quicksilver therein, attract it downward perpendicularly toward the Centre: is deduceable from hence, that if any Bubbles of aer chance to be admitted into the Tube together with the Quicksilver, that aer doth not ascend to the top of the Tube, but remains incumbent immediately upon the summity of the Quicksilver, as being, in respect of its cognation to the Earth, attracted and as it were chained down by the Magnetical, Emanations of the Earth transmitted through al interjacent bodies, and hooked upon it. For we shall not incur the attribute of arrogance, if we dare any man to assign the incumbence of the aer upon the Mercury, to any more probable Cause. It being, therefore most Verisimilous, that the Earth doth perpetually exhale insensible bodies from all points of its surface, which tending upward in direct lines, penetrate all bodies situate within the region of vapors, or Atmosphere without resistence; and particularly the masses of Quicksilver in the Tube and subjacent vessel: we can discover no shelf, that can dissuade us from casting anchor in this serene Haven; *That the magnetical Exhalations of the Earth, do possess the Desert space in the Tube, so as to exclude a sensible Vacuity.*

Art. 13. No absolute plenitude, nor absolute Vacuity, in the Desert Space: but only a *Disseminate Vacuity.*

We said, so as to exclude a *sensible Vacuity*, thereby intimating that it is no part of our conception, that either the Rayes of *Light*, or the Atoms of *Heat* and *Cold*, or the *Magnetical Effluvia's* of the Earth, or all combined together, do so enter and possess the Desert space, as to cause an absolute

ſolute Plenitude therein. For, doubtleſs, were all thoſe ſubtle Effluxions coadunated into one denſe and ſolid maſs; it would not ariſe to a magnitude equal ſo much as to the 10th, nay the 40th part of the capacity abandoned by the delapſed Mercury. But fill it to that proportion, as to leave only a *Vacuity Diſſeminate:* ſuch as is introduced into an Æolipile, when by the Atoms of fire entered into, and variouſly diſcurrent through its Concavity, the inſenſible Particles of Aer and Water therein contained, are reduced to a more lax and open order, and ſo the inane Incontiguities betwixt them ampliated. And this we judge ſufficient concerning the ſolution of the *Firſt Difficulty.*

SECT. III.

The Second Capital Difficulty.

Art. 1. The *ſecond* Difficulty ſtated.

WHat is the immediate Remora, or Impediment, whereby the Aer, which in reſpect of the natural Confluxibility of its inſenſible particles, ſo ſtrongly and expeditely præventeth any exceſſive vacuity, in all other caſes, is forced to ſuffer it in this of the Experiment?

The Solution.

Art. 2. Two things neceſſary to the creation of an exceſſive, or *præternatural Vacuity.*

Inſomuch as the *Fluidity*, or *Confluxibility* of the Atomical or inſenſible particles of the Aer, is the proxime and ſole Cauſe of Natures abhorrence of all ſenſible Vacuity; as hath been proved in the præcedent Section: Manifeſt it is, that whoſoever will admit a Vacuity exceſſive, or againſt the rite of Nature, muſt, in order to the introduction or Creation thereof, admit alſo two diſtinct Bodies; (1) One, which being moved out of its place, muſt propel the contiguous aer forward. (2) Another, which interpoſed, muſt hinder the parts of the circumſtant aer, propulſed by the parts of the aer impelled by the firſt movent, from obeying the Confluxibility of their Figure, and ſucceeding into the place deſerted by the body firſt moved.

Art. 3. The occaſion of *Galilæos* invention of a *Braſs Cylindre* charged with a wooden *Embol*, or Sucker: and of *Torricellius* invention of the præſent *Experiment.*

Which is the very ſcope, that the profound *Galilæo* propoſed to himſelf, when He invented a wooden Cylindre, as an Embolus or Sucker to be intruded into another concave Cylindre of Braſs, imperviouſly ſtopped below; that by the force of weights appended to the outward extreme, or handle thereof, the ſucker might be gradually retracted from the bottom of the Concave, and ſo leave all that ſpace, which it forſaketh, an entire and coacervate Vacuum. Upon which deſign *Torricellius* long after meditating, and caſting about for other means more conveniently ſatisfactory to the ſame intention; He moſt happily lighted upon the præſent Experiment: wherein the Quickſilver became an accommodate ſubſtitute to *Galilæo's* wooden ſucker, and the Glaſs Tube to the Braſs concave Cylindre.

The

Art. 4. [illegible] Difficul [illegible] How [illegible] can be [illegible] up- [illegible] by the [illegible] quant [illegible] ckſilver, [illegible] there externally wants a fit ſpace for it to circulate into.

The remaining part of the Difficulty, therefore, is only this relative *Scruple*; *How the Aer can be propelled by the wooden ſucker, downward, or by the reſtagnant Quickſilver in the Veſſel, upward, when externally there is provided no void ſpace for its reception*: For, indeed in the ordinary Tranſlation of bodies through the aer, it is no wonder that the adjacent aer is propelled by them; ſince they leave as much room behind them, as the aer propelled before them formerly poſſeſſed, whereinto it may and doth recur: but in this caſe of the Experiment, the condition is far otherwiſe, there being, we confeſs, a place left behind, but ſuch as the aer propelled before cannot retreat into it, in regard of the interpoſition of another denſe ſolid & impervious body. Upon which conſideration, we formerly and pertinently reflected when reciting ſome of thoſe Experiments vulgarly objected to a *Vacuum Diſſeminatum*, we inſiſted particularly upon that of a *Garden Irrigatory*: ſhewing, that the Reaſon of the Waters ſubſiſtence, or pendency therein, ſo long as the orifice in the Neb remains ſtopped, is the defect of room for the aer preſſed upon by the baſis of the Water to recur into upon its reſignation of place; becauſe all places being full, there can be none whereinto the inferior aer may recede, until upon deobſtruction of the hole above, the circumjacent aer enters into the cavity of the Veſſel, and reſignes to the aer preſſed upon below, and ſo the motion begins and continues by a ſucceſſive ſurrender of places. For, though the aer contiguous to the bottom of the Irrigatory, be not ſufficient to reſiſt the compreſſure of ſo great a weight of water, by the ſingle renitency of the Confluxibility of its atomical particles; yet the next contiguous aer, poſſeſſing the vicine ſpaces, and likewiſe wanting room to recede into, when compelled by the firſt aer, aggravates the reſiſtence: which becomes ſo much the greater, by how much the farther the preſſure is extended among the parts of the circumjacent aer; and by ſo much the farther, is the preſſure of the circumjacent aer extended, by how much the greater is the preſſure of the next contiguous aer; and that preſſure is proportionate to the degrees of Gravity and velocity in the body deſcendent. Which is manifeſtly the reaſon, why the water doth not deſcend through the perforated bottom of the Veſſel, *viz.* becauſe the Gravity thereof is not ſufficient to counterpoyſe ſo diffuſed, prolix, and continued reſiſtence, as is made and maintained by the confluxibility of the parts of the circumambient aer ſucceſſively uniting their forces.

Art. 5. The *ſolution* of the ſame, by the *Laxity* of the Contexture of the Aer

Notwithſtanding this ſeeming plenitude, we may abſolve our reaſon from the intricacy of the *ſcruple*, by returning: that, though all places about the Tube are filled with aer, yet not without ſome *Laxity*. So, though there be, indeed, no ſenſible or coacervate ſpace, wherein there are not ſome parts of the aer: yet are there many *inſenſible* or *diſſeminate* ſpaces, or *Loculaments* variouſly interſperſed among the incontiguous (in all points) particles of the aer, which are unpoſſeſſed by any Tenent at all. For the familiarizing of this Nicety, let us have recourſe once again to our ſo frequently mentioned example of a heap of Corne.

Art. 6. The ſame illuſtrated, by the adæquate *ſimile* of Corne infuſed into a *Buſhel*.

When we have poured Corne into a Buſhel up to the brim thereof; the capacity ſeems wholly poſſeſſed by the Graines of Corne, nor is there therein any ſpace, which ſenſibly contains not ſome Graines: yet if we ſhake the buſhel, or depreſs the Corne, the Graines ſink down in a cloſer poſture, and leave a ſenſible ſpace in the upper part of the buſhel, capable of

of a considerable access or addition. The reason is, that the Grains, at their first infusion, in respect of the ineptitude of their Figures for mutual contact, in all points of their superficies, intercept many empty spaces betwixt them; which dispersed minute inane spaces are reduced to one great and coacervate or sensible space, in the superior part of the Continent, when, by the succussion of the vessel, the Grains are disposed into a closer posture, *i. e.* are more accommodated for mutual contingency in their ends and sides. Thus also may aer be so compressed, as the Granules, or insensible particles of it, being reduced to a more close or dense order, by the subingression of some particles of the aer nearest to the body Compressing, into the incontiguities of the next neighbouring aer; may possess much less of space, then before compression; and consequently surrender to the body propelling or compressing, leaving behind a certain space absolutely devoid of aer, at least, such as doth appear to contain no aer.

Art. 7. A subordinate *scruple*, why most bodies are moved through the Aer, with so little resistence, as is imperceptible by sense?

But this Difficulty, *Hydra*-like, sends out two new Heads in the room of one cut off. For, Curiosity may justly thus expostulate.

(1) Have you not formerly affirmed, that no body can be moved, but it must compel the aer forward, to suffer a certain *subingression* of its insensible particles into the pores, or Loculaments of the next contiguous aer, such as is requisite to the leaving of a space behind it for the admission of the body moved? And, if so; how comes it, that when most bodies are moved through the aer, with so much facility, and therefore cause the parts thereof before them to intrude themselves into the incontiguities of the next vicine aer, with a force so small, as that it is altogether insensible: yet in this case of the *Experiment*, is required so great a force to effect the subingression and mutual Coaptation of the parts of the aer?

Art. 8. The same Expeded.

The *Cause* seems to be this. In all common motions of bodies through the liberal aer, there is left a Space behind, into which the parts of the aer may instantly circulate, and deliver themselves from compression; and so there is a subingression and Coaptation of only a few parts necessary, and consequently the motion is tolerated without any sensible Resistence: but in this Case of the Experiment, in regard there is no place left behind by the Propellent, into which the compressed parts of the aer may be effused; necessary it is that the parts of aer immediately contiguous to the body Propellent, in their retrocession and subingression compress the parts of the next contiguous aer; which though they make some resistence (proportionate to their measure of Confluxibility) do yet yeild, retrocede, and intrude themselves into the incontiguities of the next contiguous aer; and those making also some resistence, likewise yeild, retrocede, and insinuate themselves into the Loculaments of the next, which acts the like part upon the next, and so successively. So that a greater force then ordinary is required to subdue this gradually multiplied resistence successively made and maintained by the many circumfused parts of the aer; and to effect, that the retrocession, subingression and coaptation of the parts of the aer be propagated farther and farther, untill convenient room be made, for the reception of the body Propellent.

Art. 9. A second dependent *scruple* concerning the Cause of the *sensible* resistence of the Aer, in this case of the Experiment: together with the satisfaction thereof, by the *Gravity* of Aer

(2) Whence do you derive this *Resistence* of the Aer?

From its *Gravity*. For, the Aer of its own nature is Heavy, and can be said

ſaid to be *Light* only *comparatively*, or as it is leſs ponderous then Water and Earth: nor can there be given any more creditable reaſon of the Aers tendency upward here below near the convexity of the Earth, then this; that being in ſome degree ponderous in all its particles, they deſcend downwards from the upper region of the Atmoſphere, and in their deſcent bear upon and mutually compel each other, untill they touch upon the ſurface of the Earth, and are by reaſon of the ſolidity and hardneſs thereof repercuſſed or rebounded up again to ſome diſtance: ſo that the motion of the Aer upwards near the face of the Earth, is properly *Reſilition*, and no natural, but a *violent* one. Now, inſomuch as the Aer ſeems to be no other, but a common Miſcelany of minute bodies, exhaled from Earth and Water and other concretious ſublunary, and proportionately to their Craſſitude or Exility, emergent to a greater or leſs altitude: it can be no illegal proceſs for us to infer, that all parts thereof are naturally endowed with more or leſs Gravity proportionate to their particular bulk; whether that Gravity be underſtood to be (as common Phyſiology will have it) a Quality congenial and inhærent, or (as Veriſimility) their conformity to the magnetick Attraction of the Earth. And, inſomuch as this *Gravity* is the cauſe of the mutual *Depreſsion* among the particles of aer in their tendency from the upper region of the Atmoſphere down to the ſurface of the Earth: we may well conceive, that the *Depreſsion* of the inferior parts of the aer by the ſuperior incumbent upon them, is the origine immediate from whence that *Reluctancy* or *Reſiſtence*, obſerved in the Experiment, upon the induction of a præternatural Inanity between the Parts thereof. But a farther proſecution and illuſtration of this particular, depends on the ſolution of the next Problem.

Sect. IV.

The Third Capital Difficulty.

Art. 1. The State of the Third Difficulty.

What is the Cauſe of the Quickſilvers not deſcending below that determinate Altitude, or Standard of 27 digits?

Solution.

Art. 2. The Solution thereof in a Word.

The *Reſiſtence* of the parts of the aer, which endures no compreſsion, or *ſubingreſs* of its inſenſible particles, beyond that *certain proportion*, or determinate rate.

Art. 3. Three præcedent poſitions briefly recogniſed, in order to the worthy profounding of the myſtery, of the Aers reſiſting Compreſsion beyond a certain *rate*, or *determinate proportion*.

To profound this myſtery of Nature to the bottom, we are to requeſt our Reader to endure the ſhort recognition of ſome paſſages in our præcedent diſcourſes. (1) That upon the ordinary tranſlation of bodies through the Aer, the reſiſtence of its inſenſible parts is ſo ſmall, as not to be diſcoverable by the ſenſe; becauſe the ſubingreſsion of its contiguous parts into the loculaments of the next vicine aer, is only perexile, or ſuperficial: and that we may ſafely imagine this ſuperficial ſubingreſsion not to be extended beyond the thickneſs of a ſingle hair; nay, in ſome caſes

caſes, perhaps, not to the hundreth part thereof. *So ſtupendiouſly ſubtle are the fingers of Nature in many of her operations.* But, that the reſiſtence obſerved in the preſent Experiment, for the enforcing of a præternatural Vacuum, is therefore deprehenſible by the ſenſe, becauſe in reſpect of a defect of place behind the body propellent, into which the parts of the aer compelled forward may circulate, the ſubingreſſion muſt be more profound; and ſo the reſiſtence being propagated farther and farther by degrees, muſt grow multiplied, and conſequently ſenſible. (2) That the Force of the body propellent is greater, then the force of the next contiguous aer protruding the next, and the force of the third protruded wave of the aer (for a kind of Undulation may be aſcribed to aer) greater on the Fourth, then that of the Fourth upon the Fifth, and ſo progreſſionally to the extrem of its diffuſion or extenſion: ſo that the Force becomes ſo much the weaker and more oppugnable, by how much the farther it is extended; and dwindles or languiſhes by degrees into a total ceſſation. (3) That, as upon the ſuccuſſion, or ſhock of a Buſhel apparently full of Corn, is left a certain ſenſible ſpace above, unpoſſeſſed by any part or Grain thereof; which coacervate empty ſpace reſponds in proportion to thoſe many Diſſeminate *Vacuola*, or Loculaments intercepted among the incontingent ſides of the Grains, before their reduction to a more cloſe order by the ſuccuſsion of the Buſhel: ſo likewiſe, upon the impulſe of the aer by a convenient body, is left behind a ſenſible ſpace abſolutely empty, as to any part of aer; which Coacervate empty ſpace muſt reſpond in proportion to thoſe many Diſſeminate ſpaces intercepted among the incontiguous parts, or Granules of the aer, before their reduction to a more cloſe order, or mutual ſubingreſsion and coaptation of ſides and points, by the body compreſsing.

Art. 4. The *Æquiponderancy* of the External Aer, pendent upon the ſurface of the Reſtagnant Mercury, in the veſſel, to the Cylindre of Mercury reſiduous in the Tube, at the altitude of 27 digits: the cauſe of the Mercuries conſtant ſubſiſtence at that point.

Theſe Notions recogitated, our ſpeculations may progreſs with more advantage to explore the proxime and proper Cauſe of the Mercuries conſtant ſubſiſtence at the altitude of 27 digits, in the Tube perpendicularly erected. For, upon the credit of their importance, we may juſtly aſſume; that upon the compreſsion of the circumambient Aer by a ſmall quantity of Quickſilver (ſuppoſe only of two or three inches) impendent in the concave of the tube, can be cauſed, indeed, ſome ſmall ſubingreſsion of the particles thereof; but ſuch, as is only *ſuperficial* and *inſenſible*: in reſpect the weight of ſo ſmall a proportion of Quickſilver is not of force ſufficient to propel the parts of the aer to ſo great a craſsitude that the ſpace detracted from the Aggregate of Diſſeminate Vacuities ſhould amount to that largneſs, as to become viſible above the Quickſilver in the Tube; ſince the quantity of the Quickſilver being ſuppoſed little, the force of Reluctancy, or Reſiſtence in the parts of the aer, ariſing from their inhærent Fluidity, muſt be greater then the force of compreſſion ariſing from Gravity; and therefore there ſucceeds no ſenſible Deflux of the Quickſilver. But, being that a greater and greater maſs of Quickſilver may be ſucceſſively infuſed into the Tube, and ſo the compreſſive force of its Gravity be reſpectively augmented; and thereupon the aer become leſs and leſs able ſucceſſively to make reſiſtence: 'tis difficult not to obſerve, that the proportion of Compreſſion from Gravity in the Quickſilver, may be ſo equalized to the Reſiſtence from Gravity in the Aer, as that both may remain *in ſtatu quo*, without any ſenſible yeilding on either ſide. Hence comes it, that at the æquipondium of theſe two Antagoniſts, the ſpace in the

Tube detracted from the Aggregate of minute Inanities diſſeminate in the aer, is ſo ſmall as not to be commenſurated by ſenſe: and at the ceſſation of the Æquilibrium, or ſucceding ſuperiority of the encreaſed weight of the Quickſilver, the parts of the Aer being compelled thereby to a farther retroceſſion and ſubingreſſion; the ſpace detracted from the Aggregate of diſſeminate Vacuities in the aer, becomes larger, and conſequently ſenſible, above the Quickſilver in the upper region of the Tube.

Art. 5. A convenient *ſimile*, illuſtrating and enforcing the ſame.

This may be moſt adæquately illuſtrated, by the *ſimile* of a ſtrong man, ſtanding on a plane pedeſtal, in a very high wind. For, as He by a ſmall afflation or guſt of wind, is in ſome degree urged or preſt upon, though not ſo much as to cauſe him to give back; becauſe the force of his reſiſtence is yet ſuperior to that of the Wind aſſaulting and impelling him; nor, when the force of the Wind grows upon him even to an Æquilibrium, is He driven from his ſtation, becauſe his reſiſtence is yet equal to the impulſe of the wind; but when the force of the Wind advances to that height, as to tranſcend the Æquilibrium, then muſt the man be compelled above the rate of his reſiſtence, and ſo be abduced from the place of his ſtation: ſo likewiſe, while there is only a ſmall quantity of Quickſilver contained in the Tube, though, by the intervention or mediation of the Quickſilver reſtagnant in the ſubjacent veſſel, it preſs upon the parts of the incumbent aer, in ſome degree; yet is not the aer thereby urged ſo, as to be compelled to retrocede, and permit the reſtagnant Quickſilver to aſcend higher in the veſſel; and therefore the Quickſilver impendent in the Tube cannot deſcend, becauſe the reſtagnant wants room to aſcend. But, when the quantity, and ſo the Gravity of the Quickſilver contained in the Tube is ſo augmented, as to exceed the Reſiſtence of the aer; then is the aer compelled or driven back, by the reſtagnant Quickſilver riſing upwards, to a ſenſible ſubingreſſion of its atomical particles, and the Quickſilver in the Tube inſtantly defluxeth into the place reſigned by the reſtagnant, until it arriveth at that point of altitude, or ſtandard, where the reſiſtence of the aer becomes again equal to the force compreſſing it, and there ſubſiſteth, after various reciprocations up and down in the Tube.

Art. 6. The Remainder of the Difficulty; *viz.* Why *the Æquilibrium of theſe two oppoſite weights, the Mercury and the Aer, is conſtant to the præciſe altitude of 27 digits*: removed.

Now concerning the remaining, and, indeed, the moſt knotty part of the Difficulty, *viz. Why the Æquilibrium of theſe two oppoſite Forces, is conſtant to the certain præciſe altitude of 27 digits?* of this admirable Magnale no other cauſe ſeems worthily aſſignable, but this; *that ſuch is the nature of aer, in reſpect both of the atomical particles of which it is compoſed, and of the diſſeminate vacuities variouſly interſperſed among them, as that it doth reſiſt compreſſion at ſuch a determinate rate, or definite proportion, as exactly reſponds to the altitude of 27 digits.* Should it be demanded of us, Why He, who ſtands on a plane, doth reſiſt the impulſe of a mighty wind to ſuch a determinate rate or height, but not farther: we conceive our Anſwer would be ſatisfactory to the ingenious, if we returned only, that ſuch is the exact proportion of his ſtrength, reſulting from the individual temperament of his body.

Art. 7. Humane *Perſpicacity* terminated in the exterior parts of Nature, or ſimple Apparitions: which eluding our Cognition, frequently fall under no other comprehenſion, but that of rational *Conjecture*.

We are *Men, i.e. Moles*; whoſe weak and narrow Opticks are accommodated only to the inſpection of the *exterior* and *low* parts of *Nature*, not perſpicacious enough to penetrate and transfix her *interior* and *abſtruſe* Excellencies: nor can we ſpeculate her glorious beauties in the direct and incident

incident line of *Essences* and *Formal Causes*, but in the refracted and reflected one of *Effects*; nor that, without so much of obscurity, as leaves a manifest incertitude in our Apprehensions, and restrains our ambition of intimate and *apodictical Science*, to the humble and darksome region of mere superficial *Conjecture*. Such being the condition of our imperfect Intellectuals; when we cannot explore the profound recesses, and call forth the *Formal Proprieties* of some Natures, but find our disquisitive Faculties terminated in the some *Apparences*, or *Effects* of them: it can be no derogation to the dignity of *Humanity*, for us to rest contented, nay thankful to the *Bounty* of our *Creator*, that we are able to erect verisimilous Conjectures concerning their causation, and to establish such rational Apprehensions or Notions thereupon, as may, without any incongruity, be laudably accommodated to the probable solution of other consimilar Effects, when we are required to yeild an account of the manner of their arise from their proper originals. Thus, from our observation of other things of the like condition, having extracted a rational Conjecture, that this so great *Gravity* of the *Quicksilver* doth depend upon the very Contexture of its insensible particles, or minute bodies, whereof it doth consist, by which they are so closely and contiguously accommodated each to other in the superficies of their points and sides, as no body whatever (*Gold* only excepted) doth contain more parts in so small a bulk, nor consequently more *Ansulæ*, or Fastnings, whereon the *Magnetique Hooks* of the Earth are fixable, in order to its attraction downward: and on the contrary, that the so little *Gravity* of the *Aer*, depends on a quite dissimilar Contexture of its insensible particles, of which it is composed, by which they are far less closely and contiguously adapted each to other, and so incomparably fewer of them are contained in the like space, and consequently have incomparably fewer *Ansulæ* or Fastnings, whereon the Hooks of the Magnetick Chains of the Earth may be fixed: having, we said, made this probable conjecture, what can be required more at our hands, then to arrest Curiosity with this solution; that the Aer is of such a Nature, *i.e.* consisteth of such insensible particles, and such Inane Spaces interspersed among them, as that it is an essential propriety of it, to resist compression, to such a determinate rate, and not beyond? Had we bin born such *Lyncei*, as to have had a clear and perspect Knowledge of the Atoms of Aer, of their Figure, magnitude, the dimensions of the Inane spaces intercepted among them, of the facility or difficulty of their reciprocal adaptation, of the measure of their Attraction, the manner and velocity of their Tendency, &c. then, indeed, might we, without any complex circumambage of Discourse, have rendered the express and proper Reason, why the Aer doth yeild præcisely so much, and no more to the Gravity of the Quicksilver compressing it. Since we were not, it may be reputed both honour and satisfaction, to say; that it is essential to the Natures of Mercury and Aer, thus and thus opposed, to produce such and only such an Effect.

Art. 8. The constant subsistence of the Mercury at 27 digits, adscriptive rather to the *Resistence* of the Aer, then to any occult Quality in the Mercury.

However, that we may not dismiss our Reader absolutely jejune, who came hither with so great an Appetite; we observe to him, that the constant subsistence of the Mercury at the altitude of 27 digits, doth seem rather to proceed from the manifest Resistence of the Aer, then from any secret Quality in the Mercury, unless its proportion of Gravity be so conceived. This may be collected from hence; that *Water* infused into the

Tube doth alſo deſcend to the point of *Æquipondium*, and ſtops at the altitude of 32 Feet, nor more, nor leſs; and in that altitude becomes æquiponderant to the Mercury of 27 digits. So that it is manifeſt, that with what Liquor ſoever the Tube be filled, ſtill will the Aer reſiſt its deflux at a certain meaſure: provided only, that the Tube be long enough to receive ſo much of it, as the weight thereof may equal that of the Mercury at 27 digits, or the Water at 32 feet.

Art 9. The Analogy betwixt the Abſolute and Reſpective Æquality of weights, of Quickſilver and Water, in the different altitudes of 27 digits and 32 feet.

Here we meet an opportunity alſo of obſerving to Him, by how admirable an Analogy this reſpective Æquality of the weights of Quickſilver and Water, in theſe ſo different altitudes, doth conſent with the abſolute weight of each. When, as the weight of Quickſilver carries the ſame proportion to the weight of Water, of the ſame meaſure or quantity, as 14 to 1: ſo reciprocally doth the Altitude of 32 feet, carry the ſame proportion to 27 digits, as 14 to 1. And hence comes it, that, if *Water* be ſuperaffuſed upon the reſtagnant Quickſilver in the veſſel under the Tube; the Quickſilver doth inſtantly aſcend above the ſtandard of 27 digits, higher by a 14th. part of the water ſuperaffuſed. Which truly, is no immanifeſt argument, that the Aer, according to the meaſure of its weight, or the præciſe rate of its reſiſtence, becomes æquilibrated to the Mercury at the altitude of 27 dig. ſince the ſuperaffuſed Water doth no more then advance the Æquilibrium according to the rate of its weight, or proportion of reſiſtence. Beſides, it is farther obſervable, that becauſe the Tube is repleniſhed by a 14th part in 27 dig. of the altitude, above the firſt Æquilibrium (a proportionate acceſs to the Mercury in the Tube, being made by a like part of that in the ſubject veſſel, impelled into it) therefore is the *Vacuum* above the Mercury in the Tube, diminiſhed alſo by one 14th. part; and the compreſſion of the Aer, impendent on the ſurface of the reſtagnant Mercury, relaxed and diminiſhed alſo by a 14th part. So that if the veſſel underneath the Tube be large enough to admit an addition of Water ſucceſſively affuſed, until ſo much of the reſtagnant Mercury, as formerly deſcended, ſhall be again propelled up into the Tube: then muſt the whole Tube be repleniſhed, and ſo the whole Vacuity diſappear, for then all Compreſſion of the incumbent aer ceaſeth, and ſo much ſpace as was poſſeſſed before the Experiment, both without and within the Tube, by the Mercury, Water, Aer, is again repleted.

Art. 10. The definite weights of the Mercury at 27 digits, and Water at 32 feet, in a Tube of the third part of a digit in diametre; found to be near upon two pound, *Paris* weight.

If you ſhall ſtill inſiſt, and urge us to a præciſe and definite account of the weight of the Quickſilver contained in the Tube to the altitude of 27 digits, and of the Water of 32 feet; which makes the Æquilibrium with the oppoſite weight of the circumſtant Aer: our *Anſwer* is, that the exact weight of neither can be determined, unleſs the juſt Diameter or Amplitude of the Tube be firſt agreed upon. For albeit neither the Longitude nor the Amplitude of the Tube makes any ſenſible difference in this Phænomenon of the Experiment, the Æquilibrium being ſtill conſtant to the ſame altitude of 27 digits, for the Mercury, and 32 feet for Water: yet, according as the Cavity of the Tube is either ſmaller, or greater, muſt the weight of the Liquors contained therein be either leſs, or more. Since therefore, we are to explore the definite weight of the Liquor contained, by the determinate Amplitude of the Tube containing; ſuppoſe we the Diametre of the cavity of the Tube to be one third part of a * Digit, and we ſhall find the weight of the Quickſilver, from the baſe to the altitude of

* *Conſulendus* Merſennus, *in tract. de Menſuris & ponderibus, cap.* 1. *& reflection. phyſicomathemat.* p. 229.

of 27 digits, to be near upon two pound, *Paris* weight: and upon consequence the weight of Water in the same Tube, of 32 feet in altitude, to be the same; and the weight of the Cylindre of Aer, from its base incumbent on the surface of the restagnant Quicksilver, up to its top at the summity of the Atmosphere, to be also the same; otherwise there could be no Æquilibrium. Here, as a *Corollary*, we may add, that insomuch as the force of a body Attrahent may be æquiparated to the weight of another body spontaneously descending or attracted magnetically by the Earth: thereupon we may conclude, that the like proportion of weight appended to the handle of the wooden Sucker, may suffice to the introduction of an equal vacuum, in *Galileo's* Brass Cylindre.

Art. 11. *Quære*, Why the *Æquilibrium* is constant to the same point of altitude in a Tube of a large concave, as well as in one of a small; when the force of the Depriment must be greater in the one, then the other.

But, perhaps, you'l *object*; that this seems rather to entangle then dissolve the Riddle. Since by how much the larger the cavity of the Tube, by so much the greater the quantity, and so the weight of the Quicksilver contained: and by how much the greater the weight, or force of the Depriment, by so much the more must the Depressed yeild, and consequently, so much the lower must the Æquilibrium be stated.

Art. 12. The solution thereof by the appropriation of the same Cause, *which makes the descent of two bodies, of different weights, æquivelox.*

To extricate you from this Labyrinth, we retort; that the cause of the Æquilibriums constancy to the point of 27 digits, whatever be the quantity of the Mercury contained in the Tube, is the same with that, which makes the descent of two bodies of the same matter, but different weights, to be *Æqually Swift*; for a bullet of Lead of an ounce, falls down as swiftly as one of 100 pound. For, in respect, that a Cylindre of Quicksilver contained in a Tube of a large diametre, doth not descend more swiftly, then a Cylindre of Quicksilver contained in a Tube of a narrow diametre: therefore is it, that the one doth not press the bottom, upon which as its Base, it doth impend, more violently then the other doth press upon its Base; and consequently, the restagnant Quicksilver about the larger Cylindre doth not, in its elevation or rising upward, more compress the Basis of the impendent Cylindre of Aer, then what is restagnant about the lesser Cylindre. Whereupon we may conclude, that a great Cylindre of Aer resisting a great Cylindre of Quicksilver, no less then a small doth resist a small: therefore ought the Æquilibrium betwixt the depressure of the Quicksilver, and the resistence of the circumstant Aer, to be constant to the altitude of 27 digits, aswell in a large, as a narrow Tube. Which reason may also be accommodated to *Water* and all other *Liquors*.

SECT.

Sect. V.

The Fourth Capital Difficulty.

Art. 1. The Fourth Capital Difficulty proposed.

WHy is the deflux of the Quicksilver always stinted at the altitude of 27 digits, though in Tubes of different longitudes? when it seems more reasonable, that according to the encrease or enlargement of the Inanity in the upper part of the Tube, which holds proportion to the Longitude thereof; the Compression, and so the Resistence of the Aer circumpendent, ought also to be encreased proportionately: and consequently, that the Æquilibrium ought to be so much the higher in the Tube, by how much the greater Resistence the Aer makes without; because, by how much a larger Space is detracted from the Aer, by so much more diffused and profound must the subingression of its Atomical Particles be, and so the greater its resistence.

Solution.

Art. 2. The full solution thereof, by demonstration.

Certain it is, aswel upon the evidence of sense, as the conviction of several demonstrations excogitated chiefly by *Mersennus (in Phænom. Hydraulic.)* that a Cylindre of any Liquor doth with so much the more force or Gravity impend upon its Base, or bottom, by how much the higher its perpendicular reacheth, or, by how much the longer it is: and consequently, having obtained a vent, or liberty of Exsilition below at its Base, issues forth with so much the more rapidity of motion. And this secret reveals what we explore. For, according to the same scale of Proportions, we may warrantably conceive; that, by how much the higher the Cylindre of Quicksilver is in the Tube, by so much the more forcibly it impendeth upon its Base, in the Restagnant Quicksilver; and so having obtained a vent below, falleth with so much the more rapidity of motion or exsilition thereupon: and upon consequence, by so much the more violently is the incumbent Aer compressed by the restagnant Quicksilver ascending, its resistence overcome, and the subingression of its insensible particles into the inane Loculaments of the vicine aer, propagated or extended the farther; and the space detracted from the Aggregate of Disseminate Inanities, so much the larger, and consequently the *Coacervate Vacuum* apparent in the superior region of the Tube, becomes so much the greater. And, because the Resistence made against the subingression, dilating or distending it self, is in the instant overcome, by reason of a greater impulse caused by the Cylindre of Mercury descending from a greater altitude; and that resistence remains, which could not be overcome, by the remnant of the Mercury in the Tube, at the height of 27 digits: therefore, is this Remaining Degree of resistence, the manifest Cause, why the Mercury is Æquilibrated here at the point of 27 digits, aswell when it falls from a high as a low perpendicular.

Art. 3. The same confirmed, by the theory of the Cause of the Mercuries frequent *Reciprocations*, before it acquiesce at the point of Æquipondium.

This may receive a degree of perspicuity more, from the transitory observation of those frequent *Reciprocations* of the Quicksilver, at the first deflux

deflux of it into the reſtagnant, before it acquieſce and fix at the point of *Æquiponderancy*: no otherwiſe then a Ball bounds and rebounds many times upon a pavement, and is by ſucceſſive ſubſultations unceſſantly agitated up and down, untill they gradually diminiſh and determine in a ceſſation or quiet. The *Cauſe* of which can be no other then this; that the extreme or remoteſt ſubingreſsion of the inſenſible particles of the Aer, is (we confeſs) propagated ſomewhat farther, then the neceſſity of the *Æquipondium* requireth, by reaſon of a new acceſs of Gravity in the Quickſilver; but, inſtantly the inſenſible particles of the Aer, being ſo violently and beyond the rate of ſubingreſſibility preſt upon, and made as it were more powerful by their neceſſary Reflexion, then the reſidue of Quickſilver remaining in the Tube; reſult back to their former ſtation of liberty, with that vehemency, as they not only prævent any further ſubingreſſion, and reduce the even-now-ſuperior and conquering force of the Quickſilver to an equality; but alſo repell the Quickſilver delapſed up again into the Tube above the point of the Æquipondium: and again, when the Quickſilver defluxeth, but not from ſo great an altitude, as at firſt; then is the Aer again compelled to double her files in a countermarch, and recede from the reſtagnant Quickſilver, though not ſo far, as at firſt charge. And thus the force of each being by reciprocal conqueſts gradually decreaſed, they come to that Equality, as that the Quickſilver ſubſiſts in that point of altitude, wherein the Æquilibrium is.

SECT. VI.

The Fifth Capital Difficulty.

Art. 1. The Fifth Principal Difficulty.

WHat Force that is, whereby the Aer, admitted into the lower orifice of the Tube, at the total eduction thereof out of the reſtagnant Quickſilver and Water; is impelled ſo violently, as ſufficeth not only to the elevation of the remaining Liquors in the Tube, but even to the diſcharge of them through the ſealed extreme, to a conſiderable height in the Aer?

Solution.

Art. 2. Solved, by the Motion of *Reſtauration* natural to each inſenſible particle of Aer.

The immediate *Cauſe* of this impetuous motion, appears to be only the *Reflux*, or *Reſilition* of the ſo much compreſſed Baſis of the Cylindre of Aer, impendent on the ſurface of the Reſtagnant Liquors, Quickſilver and Water, to the natural Laxity of its inſenſible particles upon the ceſſation of the force Compreſſive: the Principle, and manner of which *Reſtorative* or *Reflexive* Motion, may be perſpicuouſly deprehended, upon a ſerious recognition of the Contents of the laſt Article in the præcedent Chapter of a *Diſſeminate Vacuum*; and moſt accommodately Exemplified in the diſcharge or exploſion of a bullet from a *Wind-Gun*. For, as the inſenſible particles of the Aer included in the Tube of a Wind-Gun, being, by the Embolus or Rammer, from a more lax and rare contexture, or order, reduced to a more denſe and cloſe (which is effected, when they are made more contiguous in the points of their ſuperfice, and ſo compelled to di-

minish the inane spaces interjacent betwixt them, by subingression) are, in a manner so many Springs or Elaters, each whereof, so soon as the external Force, that compressed them, ceaseth (which is at the remove of the Diaphragme or Partition plate in the chamber of the Tube) reflecteth, or is at least reflected by the impulse of another contiguous particle: therefore is it, that while they are all at one and the same instant executing that Restorative Motion, they impel the Bullet, gaged in the canale of the Tube, before them with so much violence, as enables it to transfix a plank of two or three digits thickness. So also do the insensible Particles of the Base of the Cylindre of Aer incumbent on the surface of the Restagnant Liquors, remain exceedingly compressed by them, as so many Springs bent by external Force: and so soon as that Force ceaseth (the Quicksilver in the Tube, after its eduction, no longer pressing the Restagnant Mass of Quicksilver underneath, and so that by his tumefaction no longer pressing the impendent Aer) they with united forces reflect themselves into their natural rare and liberal contexture, and in that Restorative motion drive up the remainder of Quicksilver in the canale of the Tube to the upper extreme thereof with such violence, as sufficeth to explode all impediments, and shiver the glass.

Art. 3. The incumbent Aer, in this case, equally distressed, by two contrary Forces.

For, in this case, we are to conceive the Aer to be æqually distressed betwixt two opposite Forces; on *one* side by the Gravity of the long Cylindre of Aer from the summity of the Atmosphere down to the Base impendent on the superfice of the Restagnant Liquors; on the *other*, by the ascendent Liquors in the subjacent vessel, which are impelled by the Cylindre of Quicksilver in the tube, descending by reason of its Gravity: and consequently, that so soon as the *obex*, *Barricade*, or impediment of the Restagnant Quicksilver, is removed, the distressed Aer instantly converteth that resistent force, which is inferior to the Gravity of the incumbent aereal Cylindre, upon the remainder of the Quicksilver in the Tube, as the now more superable Opponent of the two; and so countervailing its Gravity by the motion of Reflexion or Restoration, hoyseth it up with so rapid a violence, as the easily frangible body of the Glass cannot sustain.

Art. 4. The motion of *Restauration* in the Aer, extended to the satisfaction of another consimilar *Doubt*, concerning the subintrusion of *VVater* into the Tube; if superaffused upon the restagnant Mercury.

Which Reason doth also satisfie another *Collateral Scruple*, viz. *Why Water, superaffused upon the Restagnant Quicksilver, doth intrude it self as it were creeping up the side of the Tube, and replenish the Desert Space therein; so soon as the inferior orifice of the Tube is educed out of the Restagnant Quicksilver, into the region of Water.* For, it is impelled by the Base of the Aereal Cylindre exceedingly compressed, and relaxing it self: the resistence of it, which was not potent enough to prævail upon the greater Gravity of the Quicksilver in the Tube, so as to impel it above the point of Æquiponderancy; being yet potent enough to elevate the Water, as that whose Gravity is by 13 parts of 14 less then that of the Quicksilver.

Art. 5. A Third most important *Doubt*, concerning the non-apparence of any Tensity, or Rigidity in the region of Aer incumbent upon the Restagnant Liquors.

Here the Inquisitive may bid us stand, and observe a second subordinate *Doubt*, so considerable, as the omission of it together with a rational solution, must have rendred this whole Discourse not only imperfect, but a more absolute Vacuum, *i.e.* containing less of matter, then the Desert Space in the Tube; and that is: *How it comes, that during the Æquilibrium*

librium betwixt the weight of the Quicksilver in the Tube on the one hand, and the long Cylindre of Aer on the other, even then when the Base of the Cylndre of Aer is compressed to the term of subingression; we find the aer as Fluxile, soft, and yeilding, (for, if you move your hand traksversly over the Restagnant Quicksilver, you can deprehend none the least Tensity, Rigidity, or Urgency thereabout) as any other part of the Region of Aer not altered from the Laxity of its natural contexture?

Art. 6. The *solution* thereof, by the necessary relidtion of a space in the vicine region of *Lax* aer, equal to that, which the Hand commoved possesseth in the region of the *Compress.*

We reply, that though nothing occurr in the whole Experiment more worthy our absolution; yet nothing occurrs less worthy our admiration then this. For, if my hand, when moved toward the region of the compressed Aer, did leave the space, which it possessed before motion, absolutely Empty, so as the aer impelled and dislodged by it could not circulate into the same; in that case, indeed, might I perceive, by a resistence obvening a manifest Tensity or Rigidity in the compressed aer: but, insomuch as when my hand leaves the region of the lax aer, and enters that of the compressed, there is as much of space left in the lax aer for the compressed to recurr into, as that which my hand possesseth in the region of the compressed; and when it hath passed through the region of the compress'd, and again enters the confines of the lax, there is just so much of the lax aer propelled into the space left in the compressed, as responds in proportion to the space possessed by it in the lax: therefore doth my hand deprehend no sensible difference of *Fluxility* in either, and yet is the Urgency or Contention of the Base of the Cylindre of aer impendent upon the restagnant Quicksilver, constantly equal, though it may be conceived to suffer an *Undulation* or Wavering motion by the traversing of my hand to and again, by reason of the propulse and repulse.

Art. 7. A confirmation of the same Reason, by the adæquate Example of the *Flame* of a *Tapour.*

This may be enforced by the *Example* of the *Flame* of a Candle; which though ascending constantly with extreme pernicity, or rapidity of motion, and made more crass and tense by the admixture of its own fuliginous Exhalations: doth yet admit the traversing of your finger to and fro through it so easily, as you can deprehend no difference of Fluxility between the parts of the Flame and those of the circumvironing Aer; the cause whereof must be identical with the former.

Art. 8. 2 By the Experiment of *Urination.*

Secondly, by the Experience of *Urinators* or Divers; who find the Extension and contraction of their arms and legs as free and easie at the depth of 20 fathoms, as within a foot of the surface of the Water; notwithstanding that water comes many degrees short of Aer, in the point of * Fluidity.

* *Quam ob caussam, corpus hominis ad quantumvis immersum aquæ profunditatem nullum incumbentis aquæ pondus sentiat, lector petat ex* Mersenno phænom. Hydraulic. propos. 49. p. 205.

Art. 9. 3 By the *Beams* of the *Sun*, entring a room, through some slender crany, in the appearance of a *white shining VVand*, and constantly maintaining that Figure, notwithstanding the agitation of the aer, by wind, &c.

Thirdly, by the *Beams of the Sun*; For, when these insinuate themselves through some slender hole or crany into a chamber, their stream or Thread of Solary Atoms appears like a *white shining wand* (by reason of those small Dusty bodies, whose many faces, or superficies making innumerable refractions and reflections of the rayes of Light towards the Eye) and constantly maintains that figure, though the wind blow strongly transverse, and carry off those small dusty bodies, or though with a fan you totally dispel them: why? Because fresh Particles of Dust succeeding into the rooms of those dispelled, and æqually refracting and reflecting the incident radii of light toward the Eye, conserve the Apparence still the same. So though the wind blow off the first Cylindre of compreſt aer, yet doth a second, a third, &c. instantly succeed into the same Space, so as that region, wherein the Base thereof is situated, doth constantly remain compreſt: because the compression of the insensible Particles of the Aer and Wind, during their Continuation in that region, continues as great as was that of the particles formerly propulsed and abduced.

Art. 10. 4 By the constancy of the *Rainbow*, to its Figure, notwithstanding the change of position and place of the cloud & contiguous aer.

And *Fourthly*, by the *Rainbow*; which persisteth the same both in the extent of its Arch, and the orderly-confused variety of Colours: though the Sun, rapt on in his diurnal tract, shifts the angle of incidence from one part of the confronting Cloud to another, every moment; and the Wind change the Scene of the Aer, and adduce consimilar small bodies, whose various superficies making the like manifold Refractions and Reflexions of the incident lines of Light, dispose them into the same colours, and præsent the eye with the same delightful Apparition.

Art. 11. *Helmonts* Delirium, that the Rainbow is a *supernatural Meteor*; observed.

Which had the Hairbrain'd and Contentious *Helmont* in the least measure understood; he must have blush't at his own most ridiculous whimsy, that the Rainbow, is *a supernatural Meteor*, or *Ens extempore created* by Divinity, as a sensible symbol of his Promise no more to destroy the inhabitants of the Earth by Water, having no dependence at all on Natural Causes: especially when the strongest Argument He could excogitate, whereby to impugn the common Theory of the Schools, concerning the production thereof, by the refraction and reflection of the rayes of the Sun incident upon the variously figured parts of a thin and rorid Cloud in opposition diametrical; was only this. *Oculis, manibus, & pedidus cognovi istius figmenti falsitatem. Cùm ne quidem simplex Nubes esset in loco Iridis. Neque enim, etsi manu Iridem finderem, eamque per colores Iridis ducerem, sensi quidpiam, quod non ubique circumquaque in aere vicino: imo non proin Colores Iridis turbabantur, aut confusionem tollerabant. (in Meteoron Anomalon.)*

Sect. VII.

The Sixth and last Capital Difficulty.

Art. 1. The sixth and last considerable Difficulty.

Upon the eduction of the lower extreme of the Tube out of the region of the Restagnant Quicksilver, into that of Water superaffused; wherefore doth the Water instantly intrude into the Tube, and the Quicksilver residuous therein by sensible degrees deflux, until it hath totally surrendred unto it?

Solution.

Solution.

This *Phænomenon* can have for its *Cause* no other but the great *Disparity of weight betwixt those two Liquors.* For, insomuch as the subsistence of the Quicksilver in the erected Tube, at the altitude of 27 digits, justly belongs to the Æquipondium betwixt it and the circumpendent Cylindre of Aer; and the proportion of Weight which Quicksilver holds to Water, is the same that 14 holds to 1: it must as manifestly, as inevitably follow, that the Water, being by so much less able, in regard of its so much minority of Weight, to sustain the impulse of the Aer unceſſantly contending to deliver it self from that immoderate Compression, must yeild to the descending Base of the aereal Cylindre, and so ascend by degrees, and possess the whole Space; every part of Quicksilver that delapseth, admitting 13 parts of Water into the Tube.

Art. 2. The clear *solution* thereof, by the great disproportion of weight betwixt *Quicksilver* and *VVater.*

Here occurrs to us a fair opportunity of erecting, upon the præmised foundation, a rational *Conjecture* concerning the *perpendicular Extent of the Region of Aer from the face of the Terraqueous Globe.* For, if Aer be 1000 times (according to the compute of the great *Mersennus* (*reflect. physicomath. pag.*104.) who exceedingly differs from the opinion of *Galilæo* (*Dialog. al. moviment. pag.* 81.) and *Marinus Ghetaldus* (*in Archimed. promot.*) both which demonstrate Aer to be only 400 times) lighter then Water, and Water 14 times lighter then Quicksilver: hence we may conclude (1) That Aer is 14000 times lighter then Quicksilver; (2) That the Cylindre of Aer æquiponderant to the Cylindre of Quicksilver of the altitude of 27 digits, is 14000 times higher; and (3) That the altitude of the Cylindre of Aer amounts to 21 Leucæ, or Leagues. Since 14000 times 27 digits (*i. e.* 378000 digits) divided by 18000 digits (so many amounting to a French League, that consisteth of 15000 feet) the Quotient will be 21.

Art. 3. A *Corollary*; the *Altitude* of the *Atmosphere* conjectured.

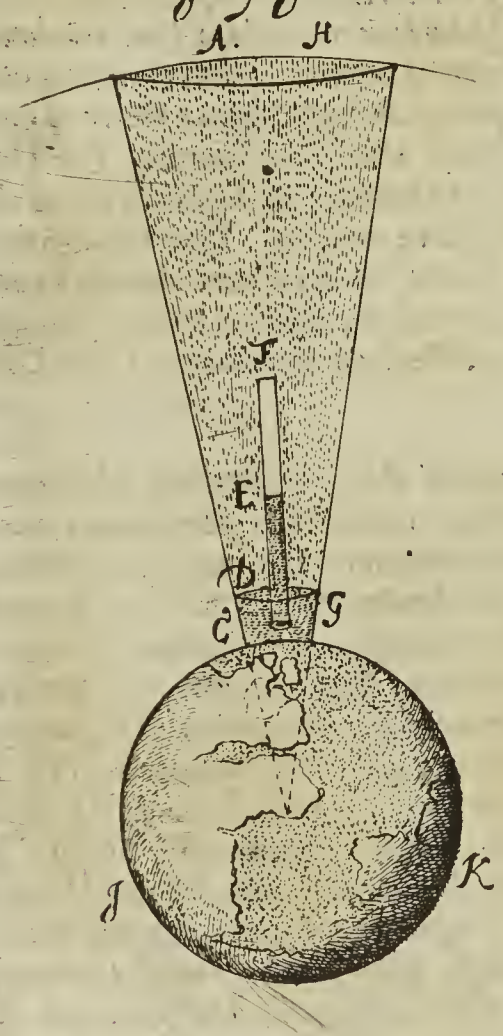
From the so much discrepant opinions of these so excellent Mathematitians, and most strict Votaries of Truth, *Galilæo* and *Mersennus*; each of which conceived his way for the exploration of the exact proportions of *Gravity* betwixt *Aer* and *Water*, absolutely *Apodictical*: we cannot omit the opportunity of observing; how insuperable a difficulty it is, to conciliate *Aristotle* to *Euclid*, to accommodate those Axioms, wch concern Quantity *abstract* from Matter, to Matter united in one notion to Quantity, to erect a solid fabrick of *Physiology* on Foundations *Mathematical.* Which Difficulty the ingenious *Magnenus* well resenting, made this a chief præparatory Axiom to his second Disputation concerning the Verisimility of *Democritus* Hypothesis of Atoms: *Non sunt expendendæ Actiones Physicæ regulis Geometricis*; subnecting this ponderous Reason, *Cum Demonstrationes Geometricæ procedant ab Hypothesi, quam probare non est Mathematici, sed alterius Facultatis, quæ eam refellit; ideo lineis Mathematicis, regulisque strictè Geometricis, Actiones Physicæ non sunt expendendæ.* (*Democrit. Reviviscent. p.*318.)

Art. 4. A second *Corollary*; the desperate Difficulty of conciliating *Physiology* to the *Mathematicks*: instanced in the much discrepant opinions of *Galilæo* and *Mersennus*, concerning the proportion of Gravity that Aer and *VVater* hold each to other.

Art. 5. The *Conclusion* of this Digression: and the reasons, why the *Author* adscribes a *Cylindrical Figure* to the portion of Aer impendent on the Restagnant Liquors, in the Experiment.

And now at length having run over these six stages, in as direct a course, and with as much celerity, as the intricacy and roughness of the way would tolerate; hath our Pen attained to the end of our *Digression*: wherein, whether we have gratified our Reader with so much either of satisfaction, or Delight, as may compensate his time and patience; we may not præsume to determine. However, this præsumption we dare be guilty of, and own; that no *Hypothesis* hitherto communicated, can be a better *Clue* to extricate our reason from the mysterious Labyrinth of this Experiment, by solving all its stupendious *Apparences*, with more verisimility, then this of a *Disseminate Vacuity*, to which we have adhæred. But, before we revert into the straight tract of our Physiological journey, the præcaution of a small *scruple* deduceable from that we have consigned a *Cylindrical Figure* to the portion of Aer impendent on the surface of the Restagnant Liquors; adviseth us to make a short stand, while we advertise; That though we confess the Diametre of the Sphere of Aer to be very much larger then that of the Terraqueous Globe, and so, that the Aer, from the Convex to the Concave thereof incumbent on the surface of the Restagnant Liquors in the vessel placed on the Convex of the Earth, doth make out the *Section* or *Frustum* of a *Cone*, whose Basis is in the summity of the Atmosphere; and point at the Centre of the Earth (as this *Diagram* exhibiteth.)

Figur pag. 60



C I K, *The Terraqueous Globe.*
B, *The Centre thereof.*
C D G, *A vessel situate on the superfice thereof.*
C, *The lower region of the vessel, filled with Quicksilver.*
G, *The upper region possessed by Water.*
F E D, *The Tube perpendicularly erected in the Vessel.*
E, *The point of Æquilibrium, at 27 dig. to which the Cylindre of Quicksilver hath descended.*
A B H, *A Cone extending from the Centre of the Earth to the convex superfice of the region of Aer*
A D G H, *A Frustum, or part of that Cone extending from the Convex to the Concave of the Aer, impendent on the surface of the Restagnant Liquors in the vessel* D C G.

Note that neither Earth, Aer, Vessel, nor Tube, are delineated according to their due proportions: since so, the Earth would have appeared too great, and the rest too small, for requisite inspection.

Yet

Yet, insomuch as the Aer is Æquiponderant to the Cylindre of Quicksilver contained in the Tube (the only requisite to our præsent purpose) no less in the Figure of a Cone, then in that of a Cylindre; and since both *Mersennus* and *Gassendus* (to either of which we are not worthy to have been a meer *Amanuensis*) have waved that nicety, and declared themselves our Præcedents, in this particular: we have thought our selves excusable for being constant to the most usual Apprehension, when the main interest of Truth was therein unconcerned.

CHAP.

CHAP. VI.

OF PLACE.

SECT. I.

Art. 1. The Identy *Essential* of a *Vacuum* and *Place*, the cause of the præsent Enquiry into the Nature of *Place*.

THat *Inanity* and *Locality* bear one and the same Notion, *Essentially*, and cannot be rightly apprehended under different conceptions, but *Respectively*; or, more expressly, that the same *Space*, when possessed by a Body, is a *Place*, but when left destitute of any corporeal Tenent whatever, then it is a *Vacuum*: we have formerly insinuated, in the *third Article*, *Sect.* 1. *of our Chap. concerning a Vacuum in Nature.* Which essential *Identy*, or only-relative *Alterity* of a *Vacuum* and *Place*, is manifestly the Reason, why we thus subnect our præsent Enquiry into the Nature or Formality of Place, immediately to our præcedent Discourse of a Vacuum: we conceiving it the duty of a Physiologist, to derive his Method from *Nature*, and not to separate those Things in his Speculation, which she hath constituted of so near Affinity in Essence.

Art. 2. Among all the *Quæries*, about the *Hoti* of Place; the most important is, Whether *Epicurus*, or *Aristotles* Definition of it, be most adæquate.

Among those numerous and importune *Altercations*, concerning the *Quiddity* or formal reason of *Place*, in which the too contentious *Schools* usually lose their Time, their breath, their wits, and their Auditors attention; we shall select only one *Quæstion*, of so much, and so general importance, that, if rightly stated, calmly and æquitably debated, and judiciously determined, it must singly suffice to imbue the mind of any the most Curious Explorator, with the perspicuous and adæquate Notion thereof.

Epicurus (in Epist. ad Herodot.) understands Place to be, τὸ διάστημα, *Intervallum illud, quod privatum Corpore, dicitur INANE, & oppletum corpore*

corpore, *LOCUS*: That Interval, or Space, which being destitute of any body, is called, a *Vacuum*, and possessed by a body, is called Place.

And *Aristotle* (in 3. *Auscult. Natur. cap.6.*) thinks He hath hit the white, when He defines Place to be, τὸ τοῦ περιέχοντος πέρας ἀκίνητον πρῶτον, *Circumdantis Corporis extremum immobile primum*; *Concava nempe, seu proxima immediataque, & ipsum locatum contingens corporis ambientis superficies*: the concave, proxime, immediate superfice of the body circumambient, touching the *Locatum*.

Now the *Difficulty* in Quæstion, is only this: Whether this Definition of *Aristotle*, or that modest Description of *Epicurus*, doth with the greater measure of verisimility and perspicuity respond to the nature of what we ought to understand, in propriety of conception, signified by the word, *Place*.

Art. 3. The Hypothesis of *Aristotles* Definition.

In order to our impartial perpension of the moments of reason on each side, requisite it is, that we first strictly ponder the *Hypothesis*, or Ground, on which *Aristotle* erected his assertion, which is this; *Præter dimensiones Corporis locati, & ipsam ambientis superficiem, nullas alias dari* (*in* 4. *Physic.* 1.) that in nature are none but *Corporeal* Dimensions: for, if we can discover any other Dimensions, abstruct from Corporiety, such wherein the formal reason of Space may best and most intelligibly be radicated; it can no longer remain in the suspence of controversie, how unsafe it is for the Schools to recurr to that superstructure, as a Sanctuary imprægnable, whose Foundation is only sand, and depends for support upon no other but a præcarious supposition.

Art. 4. A convenient *supposition* inferring the necessity of Dimensions *Incorporeal*.

Imagine we, therefore, that God should please to adnihilate the whole stock or mass of Elements, and all Concretions resulting there-from, *i. e.* all Corporeal Substances now contained within the ambite, or concave of the lowest Heaven, or Lunar Sphere: and having thus imagined, can we conceive that all the vast *Space*, or *Region* circumscribed by the concave superfice of the Lunar Sphere, would not remain the same, in all its Dimensions, after as before the reduction of all bodies included therein to nothing? Undoubtedly, that conceipt cannot endure the test of Reason, which admits, that this sublunary Space can suffer any other alteration, but only a privation of all Bodies that possessed it. Now, that it can be no Difficulty to God, at pleasure, to adnihilate all things comprehended within it; and yet at the same time to conserve the Sphere of the Moon entire and unaltered: cannot be doubted by any, but those inhumane Ideots, who dare controvert his Omnipotence.

Art. 5. The *Legality* of that supposition.

Nor can it advantage our Dissenting Brother, the *Peripatetick* to plead; that we suppose, what ought not to be supposed, an absolute *Impossibility*, as to the Firm and fundamental Constitutions of Nature, which knows no such thing, as *Adnihilation* of Elements: since, though we allow it impossible to Nature, yet can no man be so steeled with impudence, as to deny it facile to the *Author* and *Governour* of Nature; and should we conced it impossible to *Him* also, yet doth not the impossibility of any Effect interdict the *supposition* thereof as possible, in order to the appropinquation of a remote, and explanation of an obscure verity, nor invalidate that *Illation* or assumption, which by genuine cohærence depends thereupon.

Besides,

Besides, 'tis no Novelty, nor singularity in us, upon the same consideration, to suppose *Natural Impossibilities*: insomuch as nothing is more usual, nor laudable amongst the noblest order of *Philosophers*, then to take the like course, where the abstruse condition of the subject puts them upon it; and even *Aristotle* Himself hath been more then once our Præcedent and Exemplar therein. For, when He had demonstrated the Necessity of the motion or circumgyration of the Cœlestial Orbs; He yet requires of us, that we suppose them to *quiesce* constantly: that so we may the more satisfactorily apprehend the truth of that position, at which his whole discourse was collineated; *viz. that the Cause of the Earths Quiet, is not*, as some dreamed, *the rapid motion of the Heavens*; for, having cleared the eye of his Readers mind from all the dust of præsumption, with this supposition, He then with advantage demands of him, *Ubinam terra moraretur?* (2 *de Cœlo.*) Nay, even concerning this our Argument, need we not want the Authority of *Aristotle* to justifie the lawfulness of this our supposition: for, attempting to enforce, that in a large imagined Vacuum, in part whereof a Cube of Wood is conceived to be situate, there can be no Dimensions but those of the Cube; He admits them conceiveable as clearly abstracted from the mass or bulk of wood, and devested of all corporeal Accidents; wherein (under favour) He more then seems to incurr an open Contradiction of his own dear *Tenet*, that it is absurd to imagine any *Dimensions Incorporeal.* Nor is the *Facility* of our supposition less manifest then the *Lawfulness* thereof: since we dare our Opponents to produce any contemplative Person, who shall conscientiously attest, that He could not, when He fixed his thoughts thereupon, clearly and easily imagine the same; What therefore can remain to impede our progress to the *Use*, or scope of this our supposition?

Art.6. The Dimensions of Longitude, Latitude, and Profundity, imaginable in a *Vacuum*.

Having, therefore, imagined the whole sublunary Region to be one continued and entire Vacuum: we cannot but also imagine, that from any one point designed in the concave superfice of the Lunar Sphere, to another point *è diametro* opposite in the same, there must be a certain *Distance*, or *Intercedent Space.* If so; must not that Distance import a *Longitude*, or more expressly an incorporeal and invisible Line? (2) If so; must not the *medium* of that Line be the *Central point* of the empty Space, the same which stood for Centre to the Terraqueous Globe, before its adnihilation? (3) If so; may we not conceive *How much* of that voyd Region was formerly possessed by the mass of Elements: and with mental Geometry commensurate how much of that Space did once respond to the superfice, how much to the profundity of each of those Bodies? (4) If so; must we not allow the Dimensions of *Longitude*, *Latitude*, and *Profundity* imaginable therein? undoubtedly, yea: since we can no where conceive a *Distance*, or intercedent Space, but we must there also conceive a *Quantum*; and Quantity imports *Dimensions*, nor is there any Distance, but of determinate extent, and so commensurable.

Art. 7. The Grand *Peripatetick* objection, that *Nothing* is in a Vacuum; *ergo* no Dimensions

From the pressure of this Socraticism, hath our *Peripatetick* retreated to that ruinous sanctuary of the Term, *Nothing*: retarding our pursuit, with this Sophism. When you suppose the sublunary Region to be an absolute Vacuum, you expressly concede, that *Nothing* is contained therein; and upon consequence, that those Dimensions by you imagined therein, are Nothing,

Nothing, and so that therein are no Dimensions at all. Why; because Dimensions consist essentially and so inseparably in *Quantity*: and all Quantity is inseparable from *Corporiety*. Wherefore, supposing no Body existent in that Empty Space: you implicitely exclude all Quantity, and consequently all Dimensions from thence.

Art. 8. *Des Cartes*, and Mr. *VVhite* seduced by the plausibility of the same.

This Evasion, we confess, is plausible; nor hath it imposed only upon young and pædantique Prætenders to Science, such as having once read over some Epitome of the Commentaries upon *Aristotles Physicks*, and learned to cant in Scholastick Terms, though they understand nought of the Nature of the Things signified, believe themselves wise enough to rival *Solomon*: but even many grey and sage Enquirers, such who most sedulously digged for the jewel of Knowledge in the Mine of Nature, and emancipated their intellectuals betimes from the slavery of Books. For, among the most celebrated of our Modern Physiologists, we can hardly find two, who have judged it safer to abide the seeming rigour of this Difficulty, then to run upon the point of this Paradox; that, if all Bodies included in the ambite of the Lunar Heaven, were annihilated, then would there be no Distance at all betwixt the opposite sides of the same: and the Reason they depend upon, is this; Necessary it is that those points should not be distant each from other, but be contiguous, betwixt which Nothing doth intercede. Nay, even *Des Cartes* himself cannot be exempted: since, 'tis confest by him (*in Princip. Philosoph. articul.* 18.) that He subscribed the same common Mistake, in these Words: *si quæratur, quid fiet, si Deus auferat omne corpus, quod in aliquo vase continetur, & nullum aliud in abluti locum subire permittat? Respondendum est vasis latera hoc ipso fore contigua. Cum enim inter duo corpora nihil interjacet, necesse est, ut se mutuò tangant; ac manifestè repugnat, ut distent, & tamen ut distantia illa sit Nihil: quia omnis Distantia est modus Extensionis, & ideo sine substantia extensa esse non potest.* To him also may we associate Mr. *White* (*in Dialog.* 1. *de Mundo.*)

Art. 9. The Peripatetick reduction of *Time* and *Place* to the General *Categories* of *Substances* and *Accidents*, the Cause of this Epidemick mistake.

The most direct and shortest way to the *Redarguition* of this Epidemick Errour, lyes in the detection of its grand and procatarctick *Cause*; which is the Præoccupation of most Scholers minds by the Peripatetick Institutions, that limit our Notions to their imperfect Categories, and explode those Conceptions as Poetical and extravagant, that transcend their classical Distinction of all *Entities* into *Substance* and *Accident*. For, first, insomuch as in the Dialect of the Schools, those three Capital Terms, *Ens*, *Res*, *Aliquid*, are mere Synonyma's, and so used indiscriminately; it is generally concluded, that whatever is comprehensible under their signification, must be referred either to the Classis of *Substances*, or that of *Accidents*: and upon illation, that what is neither Substance, nor Accident, can prætend to no *Reality*, but must be damned to the prædicament of Chimæra's; or be excluded from *Being*. Again, having constituted *one* Categorie of all *Substances*; they mince and cantle out poor thin *Accident* into *Nine*, accounting the first of them *Quantity*, and subdividing that also into (1) *Permanent*, i. e. the Dimensions of Longitude, Latitude, Profundity; and so make Place to consist if not in all three, yet at least in one of them, *viz.* Latitude

 or

or the ſuperficies of a Body: (2) *Succeſsive, i. e.* Time and Motion, but eſpecially Time, which may be otherwiſe expreſſed by the Term, *Duration.* Hereupon, when they deliver it as oraculous, that Quantity is a *Corporeal Accident*: they confidently inferr, that if any Quantity, or Permanent, or Succeſſive, be objected, that is not or ſeparately, or conjunctly Corporeal, it ought to be exploded, as not *Real*, or an abſolute *Nothing*.

Now this their *Scheme* is defective. (1) Becauſe it fails in the General Diſtribution of *Ens*, or *Res*, into *Subſtance* and *Accident*: in regard, that to thoſe two Members of the Diviſion there ought to be ſuperadded other two, more general then thoſe; viz. *Place* and *Time*, Things moſt unreducible to the Categories of Subſtance and Accident. We ſay, *more General then thoſe Two*; becauſe as well all Subſtances as Accidents whatever, have both their Exiſtence in ſome Place, and their Duration in ſome Time; and both Place and Time are, even by thoſe who diſpute whether they are Accidents, or not, willingly granted to perſever conſtantly and invariately the ſame.

(2) Becauſe it offends Truth in the confinement of all *Quantity*, or Dimenſion, and ſo of that of Place and Time, to the Category of *Accidents*, nay even of *Corporeal* ones: when there wants not a ſpecies of Quantity, or Extenſion having Dimenſions, that is not *Corporeal*; for, nor Place, nor Time, are Corporeal. Entities, being no leſs congruous to Incorporeal, then Corporeal Beings. Upon which conſideration, 'tis a genuine and warrantable Inference; that albeit Place and Time are not pertinent to the Claſſis either of ſubſtances, or Accidents: yet are they notwithſtanding *Realities*, *Things*, or *not-Nothings*; inſomuch as no ſubſtance can be conceived exiſtent without Place and Time. Wherefore, when any Cholerick Bravo of the *Stagirites* Faction, ſhall draw upon us with this Argument; Whatever is neither Subſtance, nor Accident, is a downright Nothing, &c. we need no other buckler then to except Place and Time.

Art. 10. Place, neither *Accident* nor *Subſtance*.

To authenticate this our Schiſm, and aſſert our Affirmation; we muſt now evince, that Place is neither Accident, nor ſubſtance: which to effect, we need not borrow many moments of its Twin-brother, Time, to hunt for Arguments in. For (1) though it be objected, that Place is capable of Acceſſion to, and ſejunction from the *Locatum*, without the impairment, or deſtruction thereof; and in that relation ſeems to be a mere Accident: yet cannot that juſtifie the conſignation of Place to the Category of Accidents; becauſe Place is uncapable of *Acceſs* and *Receſs*, and 'tis the *Locatum* to which in right we ought to adſcribe *Mobility*. So that when various Bodies may be ſucceſſively ſituate in one and the ſame Place, without cauſing any the leaſt mutation therein: we muſt allow the force of this Argument, to bring it neareſt to the propriety of a ſubſtance. (2) A *ſubſtance* it cannot be; becauſe the Term, *Substance* imports ſomething, that doth not only *exiſt per ſe*, but alſo, and principally, what is *Corporeal*, and either *Active* or *Paſſive*: and neither Corporiety, nor Activeneſs, nor Paſſiveneſs, are Attributes competent to Place: *Ergo*.

Art. 11. The præcedent Giant-*Objection*, that Nothing is in a Vacuum; ſtabb'd, at a blow.

Now, to leave our roving, and ſhoot level at the mark; the Extract of

of these præmised Considerations, will easily and totally cure the desperate *Difficulty* objected. For, when it is urged, that betwixt the opposite sides of a vessel supposed to be absolutely devoyd of any Body whatever, nothing doth intercede, and consequently that they are Contiguous; we need no other *solution* but this: that (indeed) nothing *Corporeal* doth interced, betwixt the diametrally opposite sides of a voyd concave, that is either Substance, or Accident; but yet there doth intercede *something Incorporeal*, such as we understand by *Spatium*, *Intercapedo*, *Distantia*, *Intervallum*, *Dimensio*, which is neither Substance nor Accident. But, alas! that Thing you call *Space* is, according to your own supposition, an absolute *Vacuum*: What though? it must not therefore be *Nothing*, unless in the sense of the *Peripatetick*: because it hath a *Being* (*suo modo*) and so is *something*.

Art. 12. Dimensions *Corporeal* and *Incorporeal*, or *Spatial*.

The same also concerns those *Dimensions*, which we conceive, and the Schools deny to be in our imaginary Vacuum: For of them it may be likewise truly said, that they are *Nihil Corporeum*, but not that they are *Nihil Incorporeum*, or more emphatically, *Nihil SPATIALE*, Nothing *Spatial*. Hence, according to the distinction of Things into Corporeal, and Incorporeal; we may, on the design of Perspicuity, discriminate Dimensions also into (1) *Corporeal*, such as are competent to a *Body*, wherein we understand Longitude, Latitude, Profundity: (2) *Spatial*, such as are congruous to *Space*, wherein we may likewise conceive Longitude, Latitude, and Profundity. And so we may conclude, that those Dimensions, which must remain in that supposed *Inane Region* circumscribed by the concave of the Lunar Orb, in case God should adnihilate the whole mass of Elements, and all their off-springs, included therein; are, in truth, not Corporeal, but *Spatial*.

Art. 13. The former supposition reassumed and enlarged.

Let us skrew our *supposition* one pin higher, and farther imagine, that God, after the Adnihilation of this vast machine, the Universe, should create another, in all respects consimilar to this, and in the same part of Space, wherein this now consisteth: and then shall our thoughts be tuned to a fit key for the speculation, nay the comprehension of *Three* notorious *Abstrusities*, *viz.*

Art. 14. The *scope* and *advantage* thereof; *viz.* the comprehension of three eminent Abstrusities concerning the Nature of Place.

(1) That as the Spaces were *Immense*, before God created the World; so also must they eternally persist of infinite Extent, if He shall please at any time to destroy it: that He, according to the counsel of his own *Beneplacit*, elected this determinate *Region* in the infinite Spaces, wherein to erect or suspend this huge Fabrick of the World; leaving the residue which we call *Extramundan* Spaces, absolutely voyd: and that as the whole of this determinate Region of Space is adæquately competent to the whole of the World; so also is each part thereof adæquately competent to each part of the World; *i. e.* there is no part of the World, Great or Small, to which there is not a part of Space exactly respondent in all dimensions.

(2) That these immense Spaces are absolutely *Immoveable*. And therefore should God remove the World into another determinate region

of them, yet would not this Space wherein it now persisteth; accompany it, but remain immote, as now. In like manner, when any part of the World is translated from one place to another; it leaves the part of Space, which it formerly possessed, constant and immote, and the Spaces through which it passeth, and wherein it acquiesceth, continue also immote.

(3) That, in respect the Dimensions of these Spaces are Immoveable, and Incorporeal: therefore are they every where *Coexistent*, and *Compatient* (we speak in the dialect of the Schools) with Corporeal Dimensions, without reciprocal repugnancy; so as in what part soever of Space any Body is lodged, the Dimensions of that part of Space, are in all points respondent to the Corporeal Dimensions thereof. In this case, therefore, 'tis far from an Absurdity, to affirm, that *Nature doth not abhor a Penetration of Dimensions.* To bring up the rear of these advantages resulting from our supposition, we may from thence deprehend, Why *Aristotle* hath not cleft a hair in his position, that there is in the Universe no *Interval*, nor *Dimensions*, but what are *Corporeal.*

Art. 15. The *Incorporiety* of Dimensions *Spatial*, Discriminated from that of the *Divine Essence*, and other *Substances Incorporeal.*

To discriminate the *Incorporiety* of these *Dimensions Spatial*, from that adscribed to the *Divine Nature*, *Intelligences Angelical*, the *Mind of Man*, and other (if there be any) Incorporeal substances; we advertise, that the term *Incorporeal* bears a double importance. (1) It intends not only a simple *Negation* of Corporiety, and so of corporeal Dimensions; but also a true and germane *substance*, to which certain *Faculties* and *Operations* essentially belong; and in that sense it is adscriptive properly to God, Angels, the Souls of men, &c. spiritual Essences. (2) It signifies a *mere Negation of Corporiety*, and so of corporeal Dimensions, and not any positive Nature capable of Faculties and Operations; and in this sense only is it congruous to the Dimensions of Space, which we have formerly intimated to be neither *Active*, nor *Passive*, but to have only a general *Non-repugnancy*, or *Admissive Capacity*, whereby it receives Bodies either *permanentèr*, or *transeuntèr.*

Art. 16. This persuasion, of the *Improduction* and *Independency* of Place; præserved from the suspition of *Impiety.*

Here we discover our selves in danger of a nice *scruple*, deductive from this our Description of *Space*, *viz.* that, according to the tenor of our Conceptions, *Space must be unproduced by, and independent upon the original of all Things*, God. Which to prævent, we observe, that from the very word *Spatial* Dimensions, it is sufficiently evident, that we understand no other Spaces in the World, then what most of our Ecclesiastical Doctors allow to be on the outside thereof, and denominate *Imaginary*: not that they are meerly *Phantastical*, as Chimæra's; but that our Imagination can and doth apprehend them to have Dimensions, which hold an analogy to the Dimensions of Corporeal substances, that fall under the perception and commensuration of the sense. And, in that respect, though we concede them to be *improduct* by, and *independent* upon God; yet cannot our Adversaries therefore impeach us of impiety, or distort it to the disparagement of our theory: since we consider these Spaces, and their Dimensions to be *Nihil Positivum*, *i.e.* nor Substance, nor Accident, under which two Categories all works of the Creation are comprehended. Besides, this sounds much less harsh in the ears of the Church, then that which not a few of her Chair-men have adventured to patronize; viz. *that the Essences of Things are Non-principiate, Improduct, and Independent*: insomuch

insomuch as the Essence being the noblest, constitutive, and denominative part of any Thing, Substance or Accident; to hold it uncreat and independent, is obliquely to infer God to be no more then an *Adopted Father* to Nature, a *Titular* Creator, and Author of only the material, grosser and unactive part of the World.

SECT. II.

Art. 1. Place, not the immediate *superfice of the Body invironing the Locatum*; contrary to *Aristotle.*

BY the discovery of Dimensions independent upon Corporiety, such wherein the Formal reason of Space appears most intelligibly to consist, have we fully detected the weakness of *Aristotles* Basis, *præter dimensiones Corporis locati, & ipsam ambientis superficiem, nullas alias dari*: it remains only, that we demolish his thereupon-erected *Definition* of *Place*, in which his legions of *Sectators* have ingarrisoned their judgments, as most imprægnable.

That *Place* is not the immediate and contiguous *superfice* of the body invironing the *Locatum*, may by the single force of this Demonstration be fully evicted. *Immobility* is essential to Place, as *Aristotle* well acknowledged; for if Place were moveable, then would it follow of inevitable necessity, that a body might be translated without mutation of place, and *è converso*, the place of any thing might be changed, while the thing it self continues immote; both which are *Absurdities* so manifest, as no mist of Sophistry can conceal them even from the purblind multitude: Now the superfice of the Circumambient can in no wise prætend to this propriety of place, Immobility; as may be most conveniently argued from the example of a Tower; for that space, which a Tower possesseth, was there before the structure, and must remain there the same in all dimensions after the ruine thereof; but the superfice of the contiguous Aer, the immediate Circumambient, is removed, and changed every moment, the whole mass of Aer being uncessantly agitated more or less, by winds and other violences: *Ergo.* So numerous are the shifts and subterfuges of the distressed Disciples of *Aristotle*, whereby they have endeavoured to *Fix* this *Volatile* superfice of the Circumambient: that should we insist upon only the commemoration of them all; we might justly despair of finding any Charity great enough, to pardon so criminal an abuse of leasure.

Art. 2. *Salvo's* for all the Difficult *Scruples*, touching the nature of Place; genuinely extracted from *Epicurus* his Διάστημα.

Besides, from *Epicurus* διάστημα, or *Space*, we may extract *Salvo's* for all those *Scruples*, which are commonly met with by all, who worthily enquire into the nature of Place. For, when it is questioned (1) How a body can persist invariately in the same place, though the circumambient be frequently, nay infinitely varied? (2) How a body can change place, though the Circumambient accompany it in its remove? (3) Why one body can be said to be thus or thus far, more or less distant from another? we may easily satisfie all with this one obvious Answer, that all mobility is on the part of the Locatum, all Space continuing constant and immote. Further, hence come we to understand, in what respect Place is commonly conceived to be exactly *adæquate* to the *Locatum*: for, the Dimensions of all Space possessed, are in all points respondent to those of the body possessing

ſing; there being no part of the body, profound or ſuperficial, to which there is not a part of Space reſpondent in æqual extent; which can never be made out from the mere ſuperfice of the Circumambient, in which no one of the Profound or Internal parts of the Locatum, but only the *ſuperficial* are reſident. Moreover, hence alſo may we underſtand, How *Incorporeal ſubſtances*, as God, Angels, and the Souls of men, may be affirmed to be *in loco*. For, when God, who is infinite, and therefore uncapable of Circumſcription, is ſaid to be in Place; we inſtantly cogitate an infinite Space: which is more then we can do of Place, if accepted in *Ariſtotles* Notion, which imports either that God cannot be in any place, or elſe He muſt be circumſcribed by the contiguous ſuperfice thereof: which how ridiculous, we need not obſerve. For *Angels* likewiſe, who dares affirm an Angel to be in a place, that conſiders his Incorporiety, and the neceſſity of his circumſciption by the ſuperfice of the Circumambient, if *Ariſtotles* Definition of Place be tolerable? To excuſe it with a diſtinction, and ſay, that an Angel may be conceived to be in a determinate place, not *Circumſcriptivè*, but *definitivè*, *i. e.* So *Here*, as no *where* elſe: is implicitely and upon inference, to confeſs the truth of our aſſertion; Since that *Here*, deſigns a certain part of Space, not the ſuperfice of any circumambient. For, though you reply, that an Angel, being an incorporeal ſubſtance, wants as well *internal* and *profound* Dimenſions, by which his ſubſtance may reſpond to *Space*, as thoſe *ſuperficial* ones, that reſpond to *Place*: yet cannot that ſuffice to an evaſion, ſince if his ſubſtance hath any *Diffuſion* in place, as is generally allowed; and though it be conſtituted *in puncto*, as is alſo generally conceived: nevertheleſs, doth that Diffuſion as neceſſarily reſpond to a certain æqual part of Space, as a point is a determinate part of ſpace. This perhaps, is ſomewhat abſtruſe, and therefore let us conceive an Angel to be reſident in ſome one point of that *Inane Region* circumſcribed by the concave of the Lunar orb, formerly imagined: and then we may without any ſhadow of obſcurity underſtand, How his ſubſtance may reſpond to a certain part, or point of the Inane Space, ſo as He may be ſaid to be *Here*, not *There*, in this but no other place: but impoſſible it is, to make it out, How the ſubſtance of an Angel conſtituted *in puncto* of an empty ſpace, can reſpond to the ſuperfice of a Body Circumambient, becauſe all Bodies formerly included in that ſublunary Region are præſuppoſed to be adnihilated. Laſtly, by the Incorporiety of Space we are præſerved from that Contradiction, which *Ariſtotle* endeavouring to prævent, præcipitated himſelf upon no ſmall Abſurdity, *viz. that the ſupreme Heaven, or Primum mobile is in no Place.* For, if we adhere to his opinion, that place is the ſuperfice of a body circumambient; the *Primum mobile* being the extreme or bounds of the World, we deny any thing of *Corporiety* beyond it, and ſo exempt it from *Locality*: but if we accept ſpace to be the ſame without and within the world, we admit the *Primum mobile*, the nobleſt, largeſt, and moſt uſeful of all Bodies in the World, to enjoy a Place proportionate to its dimenſions, and motion, as adæquately as any other. The neceſſity of which conceſſion, *Thales Mileſius* well intimated, when interrogated, What *Thing was greateſt?* He anſwered, *Place*: becauſe, as the World contains all other Bodies, ſo Place contains the World.

Art. 3. *Ariſtotles* ultimate Refuge.

Reduced to theſe ſtraights, *Ariſtotle*, among ſundry other Sophiſms, entruſteth the laſt part of his Defence, to this ſlight *Objection*; *If Place were*

were a certain Space, constant in three dimensions; then would it inevitably follow, that the Locatum and the Locus must reciprocally penetrate each others dimensions, and so the parts of each be infinitely divided: which is manifestly absurd, since Nature knows nor penetration of Dimensions, nor infinity of corporeal division.

Art. 4. The Invalidity thereof: and the *Coexistibility*, or *Compatibility* of Dimensions *Corporeal* and *Spatial*.

To this *Induction* we could not refuse the attribute of *Probability*, no more then we do now of *Plausibility*, had we not frequently prævented it, and openly by our Distinction of Dimensions into *Corporeal* and *Incorporeal*, and appropriating the *last* to Space. For, indeed, the Fundamental Constitutions of Nature most irrevocably prohibite the substance of one Body to penetrate the substance of another, through all its Dimensions: but, alas! Place is (κυρίως ἀσώματος) properly and altogether *Incorporeal*; and therefore may its dimensions Incorporeal be *Coexistent*, or *Compatient* with the Corporeal Dimensions of any Body, without mutual repugnancy, the Spatial Dimensions not excluding the Corporeal, nor those extruding the spatial. This cannot be a *diaphanous*, or ænigmatical to those, who concede *Angels* to be *Incorporeal*, and therefore to penetrate the Dimensions of any the most solid Bodies, so that the whole substance of an Angel may be *simul & semel*, altogether and at once in the same place with that of a stone, a wall, the hand of a man, or any other body whatever, without any necessity of mutual *Repugnancy*. Nor to those, who observe the Synthesis, or Collocation of *Whiteness*, *Sweetness*, and *Qualities* in the substance of Milk: for as those are conceived to pervade the whole substance of Milk, without any reciprocal repugnancy of Dimensions, so are we to conceive that the Dimensions of Space are totally pervaded by the whole Body of the *Locatum*, without *Renitency*.

CHAP.

CHAP. VII.

OF TIME AND ETERNITY.

Sect. I.

Art. 1. The *Hoti* of Time more easily conceivable by the *Simple Notion* of the *Vulgar*, then by the *complex Definitions* of *Philosophers*.

Some *Texts* there are in the *Book of Nature*, that are best interpreted by the sense of the *Vulgar*, and become so much the more ænigmatical, by how much the more they are commented upon by the subtile discourses of the *Schools*: their over-curious *Descants* frequently rendring that *Notion* ambiguous, complex and difficult, which accepted in its own genuine *simplicity*, stands fair and open to the discernment of the unpræjudicate, at the first conversion of the acies of the Mind thereupon. Among these we have just cause to account *TIME*; since if we keep to the popular and familiar use of the word, nothing can be more easily understood: but if we range abroad to those vast Wildernesses, the Dialectical Paraphrases of Philosophers thereupon, and hunt after an adæquate *Definition*, bearing its peculiar *Genus*, and essential *Difference*; nothing can be more obscure and controversial. This the sacred *Doctor* (*August.* 11. *Confess.* 14.) both ingenuously confessed, and most emphatically expressed, in his, *Si nemo ex me quærat, quid sit Tempus, scio; si quærenti explicare velim, nescio*: intimating that the *Mind* may, indeed, at first glance speculate the nature of Time by a proper Idea; but so pale and fine a one, as

nor

nor *Tongue*, nor *Pen* can ever pourtray a lively representation thereof. And *Cicero* (1. *de invent.*) is bold to list it among the most desperate Difficulties, *Tempus definire Generalitèr.* To which we may annex that saying of one quoted by *Stobæus* (*Eccl. Phys.* 11.) *Tempus esse* Νοήμα ἢ ὑπόστασιν, *Quidpiam non re, sed cogitatione constans.* As also that of *Aristotle*, who not only injoyns, that we discourse of Time in a certain key of thought far different from that wherein we use to consider things, which have a real inhærence *in subjecto*; as if Time had no other subject of inhærence but the Mind, were only a mere *Ens Rationis*, extrinsecal Denomination, and could expect no exacter a description, then His *Numerus, qui absque ratione numerante est nullus*: but adviseth, if any shall demand, what Time is, to afford him no other but *Democritus* Answer; *Tempus esse* ἡμερεισὲς καὶ νυκτισὲς φάντασμα, *quale spatium diei noctisque apparet.*

Art. 2. The Generall præsumption that Time is *Corporeal*, or an *Accident* dependent on Corporeal Subjects; the chief Cause of that Difficulty

If we research profoundly into the *Original* of this Difficulty, of acquiring a clear and perspect theory of the *Quiddity* of Time, from the Lecture of those prolix Treatises, whose plausible Titles promise satisfaction concerning it: we shall soon find the chief *Cause* to be this; that most Philosophers have præsupposed Time to be some *Corporeal Ens*, or at least some certain *Accident* inexistent in and dependent on Corporeal Subjects; when (in verity) if it be any thing at all it seems to be the *Twin-brother* of *Space*, devoyd of all relation to Corporiety, and absolutely independent on the Existence of any Nature whatever. For, to Him, who shall, in abstract and attentive meditation, sequestre Time from all Bodies, from their motions, successive alternations, and contingent vicissitudes insequent upon those motions; *i. e.* all Years, Months, Weeks, Dayes, Hours, Minutes, Seconds, and all Accidents or Events contingent therein: it will soon appear most evident, that Time (*in suo esse*) owes no respect at all to Motion, its constancy, variety, or measure; since the understanding must deprehend Time to continue to be what it ever was and is, whether there be any Motion or Mutation in the World, or not, nay, whether there be any World or not. For, examining what is meant by the term *Duration*, and what by the term *Motion*, in their single importances apart: we discover, that Motion holds no relation to Duration, nor *è converso*, Duration to Motion, but what is purely *Accidental*, and *Mental*, i. e. imagined by man, in order to his commensuration of the one by the other.

Art. 3. The *variety of opinions*, concerning it; another Cause of the Difficulty: and *Epicurus* Description of its Essence, recited and explained.

Another *Cause* of this Difficulty, may be the irreconcileable *Discrepancy* of judgments concerning it, even among the most Venerable of the Ancients. For (1) *Epicurus* hath a complex and periphrastical Description of the Essence of Time, when He concludes it to be, Σύμπτωμα Συμπτωμάτων, παρεπόμενον ἡμέραις τε, καὶ νυξὶ, καὶ ὥραις καὶ πάθεσιν, καὶ ἀπαθείαις, καὶ κινήσεσι, καὶ μονᾶις, an *Accident of Accidents, or Event of Events, consequent to dayes and nights, and hours to passions and indolency, motion and quiet.* The reason of which *Empiricus* (2. *advers. Physic.*) by way of explanation, thus renders: Days and Nights are Accidents supervenient upon the ambient Aer, the one being caused by the præsence, the other by the absence of the Sun; Hours are also accidents, as being parts of day or night; but Time is coextended to each day, night & hour, & therefore we say, that this day is long, this night short, while our thoughts are constantly pointing

at Time in that respect supervenient; Passions likewise and Indolences, or Dolours and Pleasures, are Accidents not without Time evenient; lastly, Motion and Quiet are Accidents contingent in Time, and therefore by it we commensurate the Celerity and Tardity of Motion, the long or short duration of Quiet: therefore is Time the Accident of Accidents. And *Lucretius* alluding to the same opinion of *Epicurus*, translates his Ἀσώματον τὸ χρόνον ὑπάρχειν, *Tempus esse incorporeum*, into *Tempus item per se non est, &c. lib.* 1.

Art. 4. Time defined to be *Cœlestial Motion*, by *Zeno, Chrysippus*, &c. and thereupon affirmed, by *Philo*, to be only *Coævous to the World.*

(2) *Zeno, Chrysippus, Apollodorus, Posidonius*, and their Sectator *Philo*, define Time to be, *Motus cœlestis, sive mundani intervallum*, understanding as well all particular Conversions, as the Generality of Motion from the beginning to the end of the World. Whereupon *Philo* would inferr, that Time was *coævous* to the World, *i. e.* before the World there was no Time, nor should be any after: though the *Stoicks* unanimously defend the *Infinity* of Time, in regard they affirmed an *infinitie of Worlds successive*, the second springing up, Phænix-like, from the ashes of the first, the the third from the second, &c. (3) *Pythagoras*, according to the Records of *Plutarch* (*in quæstion. Platonic.*) to one interrogating him concerning the Essence of Time, calls it *Animam Cœli*, the soul of Heaven. To which *Plotinus* (*En.* 3. *lib.* 7. *cap.* 10.) seems to have alluded, when interpreting *Plato's* saying, that Time was the *Image of Eternity* (*in Timæo*) He make *Æternity* to be the very soul of the World, as considered *in se*, in its own simple essence; and *Time* to be the same soul of the world, considered, *prout varias mutationes suscipit*, as it admits various mutations.

Art. 5. *Aristotles* so much magnified Definition of Time, to be the *Measure of Motion Cœlestial, &c.* perpended and found too light.

(4) And *Aristotle*, as every Pædagogue hath heard, after a long and anxious scrutiny, positively and magisterially determines Time to be, *Numerum Motus* (*cœlestis ac primi*) *secundum prius & posterius*, the Number of the first Cœlestial Motion, according to former and later; *i. e.* insomuch as in Motion we may observe parts *Antecedent* and *Consequent* by a perpetual succession. At the first word of this eminent Definition, some superficial *Criticks* have sawcely nibbled, urging (forsooth) that it sounds solœcistical, because *Number* is Quantity *Discrete*, but *Time Continued*; and therefore that the Word *Measure* ought to be its substitute: but alas! had they read His whole discourse of the nature of Time, they could not have been ignorant, that *Aristotle* intended nothing less, then that Time should be reputed a Quantity *Discrete*; when both in his præcedent and subsequent lines He expresly teacheth, that *Motion is continued, in respect of Magnitude, and Time in respect of Motion.* Had They Excepted against the *whole*, indeed, their Quarrel had bin justifiable, and our selves might safely have espoused it; because, if Time be the Measure of Cœlestial Motion, then must it follow, that if there were a Plurality of Worlds, or *Prima Mobilia's*; there would also be a Plurality of Times, because a Plurality of Motions. To those of His Disciples, who reply, that in case there were many *First Moveables*, and consequently many distinct Motions; yet would there be but *one* Measure of them all: we rejoyn, if it be supposed that some of the many Motions are swifter then others, then of necessity must they have many *Prior* and *Posterior* Parts; and if so, how

how can all those, more or less discrepant in velocity and tardity, fall under one and the same measure? or, what sober man can admit, that there would be but one Time, where must be many distinct *subjects* of Motion, and so of Time? Nor can it more avail them to distinguish Time INTERNAL from EXTERNAL, assigning to each particular *Primum Mobile* a proper or *Internal* Time within its ambite, and one General or *External* Time to them all in common: because it is a manifest *Adynaton*, that there should be a General Time, without a General Motion, whose parts being prior and posterior, in respect of perpetual succession, must be the common *Norma*, or Rule of observation to all the rest; nor, indeed, can we admit, that a Flux of ten hours at once, or together, is possible, where ten Spheres are in one hour moved. And, therefore, though *Aristotle* seems to have had some Hint of the true nature of Time, in his *Objection* against those, who opinioned it to be *Cœlestial Motion*: yet he lost it again, when He defined it to be the *Measure of Cœlestial Motion.* For, Reason attesteth the contrary, it being evident that the Cœlestial Motion is rather the Measure of Time: insomuch as the measure ought to be more known then the thing measured; and Time is a certain Flux no less independent upon Motion then Quiet. Which those Worthies well understood, who confest Time to be IMAGINARY, such as flowed infinitely in duration before the Creation, and shall continue its flux infinitely after the Dissolution of the World.

SECT. II.

Art. I. Time, nor substance, nor Accident: but an *Ens* more General, and the Twin-brother of *Space*.

FAiling of satisfaction concerning the Nature of Time, from the *Definitions* of others: it remains only, that we sedulously imploy our own Cogitations in quest of some competent *Description* of it. *Seneca (in Epist.* 58.) descanting upon *Plato's* General Distinction of all Entities into six *Classes*, saith thus; *Sextum Genus est eorum, quæ quasi sunt, tanquam Inane & Tempus,* the sixth Genus contains only those things, which have *as it were* a being, as INANITY and TIME: which we thus expound, *Space and Time are things more General then to be comprehended under the Categories of Substance and Accident.* With this Text we had not long exercised our thoughts, before we conceived, that the most hopeful way for exploring the mysterious *Quiddity* of Time, lay in the strict examen of the *Affinity* or *Analogy* betwixt it and the subject of our immediately præcedent Chapter, *Space.* Nor did our Conjecture prove abortive; for, having confronted their proprieties in all points, we soon found their Natures fully correspondent: so as the Notion of one seems involved in that of the other; as is manifest in this *Paralellism.*

Art. 2. A *Paralellism* betwixt Space and Time.

(1) As Place, or Space, in the total, is *illimitate* and *immense*: so is Time, in its totality, *non-principiate* and *interminable.* (2) As every *Moment* of Time is the *same* in all places: so is every *canton* or part of Place the *same* in all times. (3) As Place, whether any, or no Body be *collocated* therein, doth still persist the same immoveable and invariately: so doth unconcerned Time flow on eternally in the same calm and

equal tenór, whether any or nothing hath *duration* therein, whether any thing be moved or remain quiet. (4) As Place is uncapable of *expanſion, interruption* or *diſcontinuity*, by any Cauſe whatever: ſo is Time uncapable of *acceleration, retardation*, or *ſuſpenſion*; it moving on no leſs, when the Sun was arreſted in the midſt of its race in the dayes of *Joſhua*, when the Hebrews vanquiſhed & purſued the Amorrhites, then at any time before, or ſince. (5) As God was pleaſed, out of the *Infinite Space* to elect a certain determinate *Region* for the *ſituation*: ſo hath He, out of *Infinite Time*, elected a determinate *part* for the *Duration* of the World. (6) And therefore, as every Body, or Thing, in reſpect to its HERE or THERE, enjoyes a proportionate part of the *Mundane Space*: So likewiſe doth it, according to its NOW, or THEN of Exiſtence, enjoy a proportionate part of the *Mundane Duration*. (7) As, in relation to Place, we ſay, *Everywhere*, and *Somewhere*: ſo, in relation to Time, we ſay, *Always*, and *Sometimes*. Hence, as it is competent to the *Creature* to be only ſomewhere, in reſpect of Place, and ſometimes, in reſpect of Time: ſo is it the prærogative of the *Creator*, to be Everywhere as to place, and Forever, as to time. And therefore thoſe two illuſtrious Attributes, *Immenſity*, whereby He is præſent in all places, and *Æternity*, whereby He is exiſtent at all Times, are proper only to God. (8) As Place hath Dimenſions *Permanent*, whereby it reſponds to the Longitude, Latitude, and Profundity of *Bodies*: ſo hath Time Dimenſions *ſucceſsive*, to which the *Motions* of Bodies may be adæquated. Hence comes it, that as by the Longitude, of any ſtanding meaſure (V.G.) of an Ell, we commenſurate the longitude of Place: ſo by the flux of an Horologe do we commenſurate the flux of Time. And, inſomuch as no motion is more General, Conſtant and Obſerved, then that of the Sun: therefore do we aſſume its motion for a *General Horodix*, by it regulate all our computations, and confide in it as an univerſal Directory, in our Menſuration of the flux of Time. Not that the Feet of Time are chained to the Chariot of the Sun, ſo as the Acceleration or Retardation of the motion of that ſhould cauſe an equal Velocity, or Tardity in the progreſs of this: but that Cuſtom hath ſo prævailed, as we compute the flux of Time by the diurnal and annual revolution of the Sun. For, in caſe the motion of the Sun were doubly ſwifter, then now it is, that of Time would not therefore be doubly ſwifter alſo; but only the ſpace of two dayes would then be equal to the ſpace of one, as now during the præſence of the Sun to our Hemiſphere: nor, on the contrary, if the motion of the Sun were doubly ſlower, would the pace of Time be likewiſe doubly ſlower; but only the Space of one day, would be equal to that of two. And, therefore, He that will defend *Empedocles* conceit, that in the beginning of the World, the length of the dayes did by ſix parts in ſeven exceed that of our dayes: muſt demonſtrate that the urnal Arch of the Sun was then by ſix of ſeven larger then now, or its motion ſo much ſlower.

Art. 3. Time, *Senior* unto, and *independent* upon Motion: and only accidentally *indicated* by Motion, as the *Menſuratum* by the *Menſura*.

From this *Paralelliſm* 'tis difficult not to conclude, *that Time is infinitely elder then Motion*, and conſequently *independent* upon it: as alſo, that Time is only indicated by Motion, as the *Menſuratum* by the *Menſura*. For, inſomuch as it had been otherwiſe impoſſible for Man to have known how much of Time He had ſpent either in action, or reſt; therefore did He fix his obſervation upon the Cœleſtial motion, and compute the quantity of Time præterlapſed by the Degrees of the Suns motion in the Heavens.

vens. And becauſe the obſervation of the Suns motion was eaſie and familiar; therefore did the Ancients invent ſeveral inſtruments, as *Water* and *Sand Hour-glaſſes*, and *Sun-dials*, and the Neotoricks *Trochiliack Horodixes*, circumgyrated by internal ſprings, or external weights appenſed; and ſo artificially adæquated them to the motion of the Sun, that defines the day by its præſence, and might by its abſence, as having ſubdivided their horary motions into equal ſmaller parts, at laſt they deſcended to the deſignation of each ſtep in the progreſs of Time, *i.e.* to the computation even of Minutes and Seconds.

Art. 4. A *demonſtration* of the independence of Time upon Motion, from the miraculous *Detention of the Sun*, above the Horiſon, in the days of *Joſhua*.

If any yet doubt (which we cannot ſuppoſe, without implicite ſcandal) of the *Independence* of *Time* on *Cœleſtial Motion*; or, that old *Chronos* muſt ſtand ſtill, in caſe the *Orbs* ſhould make a Halt: we adviſe him ſeriouſly to perpend that *ſupernatural Detenſion* of the Sun in the day of battle betwixt the Iſraelite and the Amorrhite; aſſuring our ſelves that his thoughts will ſoon light upon this *Apodictical Argument*. Either there was no Time during the Ceſſation of the Suns motion on that day; or elſe Time kept on its conſtant flux: for one of theſe poſitions muſt be true. That the *Firſt* is *falſe*, is manifeſt from the extraordinary *Duration* of the day, the *Text* poſitively expreſſing, *that no day was ere, nor ſhould be ſo long as that*; and the word *Long* undeniably importing a *Continued flux* of time: *Ergo*, the *ſecond* muſt be moſt *true*; and upon Conſequence, though the *Detention* of the Sun was *miraculous*, yet was the *Duration* of the day *Natural*, becauſe Time hath no dependence on Cœleſtial Motion.

Art. 5. An *Objection*, that, during the arreſt of the Sun, there was no *Time*, becauſe no *Hours*; ſatisfied.

Nor do they at all infirm the news of this *Dilemma*, who *object*; *that there was then no Time, becauſe there were no Hours*: ſince Hours are no more Eſſential to Time then *Spring*, *Summer*, *Autumn*, and *Winter*, which are only ſucceſſive mutations of the temperament of Aer, convenient to the conſervation and promotion of ſeminalities; and as for *Dayes*, they likewiſe are abſolute Aliens to Time, ſince while our Hemiſphere enjoyes the illumination of the Sun, the ſubterraneous one wants it, and ſo our day is night to the Antipodes inhabiting the oppoſite part of the Globe Terreſtrial; but Time is conſtantly the ſame through the Univerſe. Beſides, there were Hours during the arreſt of *Don Phæbus*; in this reſpect, that the ſpace of Time, in which he ſtood ſtill, was deſignable by the flux of Hour-glaſſes, or any other Temporary Machine: nor ought we to ſay, there are no hours but thoſe which we commenſurate. And therefore, we incur no *Solœciſm* when we ſay, that God, had it ſeemed good in the eye of his Wiſdom, might have created the World many thouſands of millions of *years* ſooner then He did: becauſe ſuch was the præcedent Flux of Time as might be computed by Spaces of Duration in longitude reſpondent to that determinate ſpace of Time, which the Sun in its progreſs through the Zodiack annually doth fulfill; not that before the Creation, there were real years, diſtinct and defined by the repeated Converſions of the Sun.

Art. 6. The *Immutability* of Time alſo aſſerted, againſt *Ariſtotle*.

Further, As Time hath no Dependence on, ſo can it receive no *Mutation* from Motion. *Ariſtotle*, indeed, accuſeth it of *Mutability*, merely becauſe we uſe to connect that Time in which we fall aſleep, to

to that in which we awake, losing that of which the cessation of our senses operation makes us insensible: But alas! this looks like too weak a conceit to be the mature issue of so strong a brain as His; insomuch as albeit we concede some Mutations to be necessary, as to our *perception* of the flux of Time, yet doth it not follow, that therefore those Mutations are necessary; as to the *Flux of Time it self.* True it is also, that we use to measure various Mutations by Time: but if we examine the matter profoundly, we shall animadvert, that the Time, during which those Mutations last, is rather measured by Motion then the contrary; for though that motion be not observed in the Heavens, yet may it be æquivalent indicated by Hour-Glasses, or any other *Chronodix.* Which *Aristotle* himself seems to acknowledge (in 12. *de Cœlo*) when He affirms, *that as Motion may be measured by Time, so may time by Motion.*

Sect. III.

Art. 1. The Grand Quæstion, concerning the *Disparity* of *Time* and *Eternity*; stated.

If Time be, as our Description imports, *Non-principiate* and *Infinite*: how can we *Discriminate* it from *Æternity?* Should we resolve, that *Æternity*, in the ears of an unpræjudicate understanding, sounds no more then PERPETUAL DURATION, or Time that never knew beginning, nor can ever know an end: we are instantly assaulted with this Difficulty; that *Time* hath Dimensions successive, comprehends Priority and Posteriority of parts, and essentially consisteth in a certain perpetual Flux; but *Eternity* is radicated in one permanent point, falls under none but the Præsent Tense, and is only a certain constant τὸ νῦν, or intransible NOW; or, as *Boœtius* defines it, *Interminabilis vitæ tota simul & perfecta possessio*, an interminable and perfect possession of life altogether, *i. e.* without præterite and future, or, *Forever at once.* To extricate our selves from this seeming Confusion of two things, whose Natures appear so irreconcileably disparate; we are to begin at two prævious Considerables.

Art. 2. Two præparatory Considerations, touchant the æquivocal use of the word *Æternity*; requisite to the clear solution thereof.

(1) That *Plato* (out of whose *Timæus* that eminent Definition of *Boœtius* was extracted, which hath received the approbation and praises of most of our Ecclesiastick Patriarchs) asserting his opinion, that *Immutable and Eternal Natures are not subject to Time*, to which *Aristotle* also assented; doth not intend the word, *Æternity*, abstractly and præcisely, to signifie a species of *Duration*: but Concretely, for *something whose Duration is Eternal*, viz. the *Divine Substance*, which He otherwise calls, the *Soul of the World.* This may be, without violence or sinister perversion, collected from hence, that He dislikes the incongruous conference of both and either of those Tenses, *Fuit* and *Erit*, as well upon *Eternity* or interminable Duration, abstractly considered; as ὅτι τοῦ αἰῶνος οὐσίαν, upon the *Eternal Substance.* And *Plotinus* (*En.* 3. *lib.* 7. *cap.* 1.) more then once expresly declares as much: and most ingeniously insinuates the same both when He derives the word

word Æternity, τ αἰῶνα, ἀπὸ τȣ̃ ἀεὶ ὄντος, *ab eo quod semper est*; and when he excludes all real Alterity, or difference from τὸ ὄν, *quod est*, and τὸ ἀεὶ ὄν, *quod semper est*, importing that *Is* and *Eternity* are *Identical.*

(2) That when *Plato* denieth the Congruity of *Præterite* and *Future*, but allowes that of the *Præsent* Tense, or *Est*, to the *Eternal Substance*; He only aims at this, that, saying of the Eternal Substance, *Fuit*, *it hath been*, we do not understand it the same with *Non amplius est*, *it is no more*; and also when we say of it, *Erit*, *it shall be*, we do not understand it as *Nondum est*, *it is not yet*: but not that *Fuit* is incompetent to the Eternal Substance, provided we intend that it doth now continue to be the same it ever hath been; nor *Erit*, while we conceive it shall be to all Eternity the same, that it ever hath been, and now is. It being manifest from the Syntax and purport of all his Dialogue, that his cardinal scope was only to prævent the dangerous adscription of those *temporary Mutations* to the *Eternal Being*, which are properly incident to *Generable* and *Corruptible* Natures: and to demonstrate, that we ought to conceive God, ȣ̃τε πρεσβύτερον, ȣ̃τε νεώτερον, *neque seniorem*, *neque juniorem.* In a word, *Plato* doth judge, that the Tense *Est* is proper only to the *Divine Nature*, because it is ever the same, or invariably possesseth the same perfections, nor is there any moment in the vast amplitude of Eternity, wherein it can be justly said, Now it hath some Attribute, which it had not formerly, or which it shall not have in the future: since the progress of Time can neither add any thing unto, nor detract any thing from it, as it doth to other Natures, that are obnoxious to mutation; so that God may well be called, in *Plato's* Phrase, ἔχων ἀκινήτως, *Habens se immobiliter.*

Art. 3. Two decisive *Positions*, thereupon inferred, and established.

These remora's of ambiguity removed, we may uninterruptedly advance to inference, and without further hæsitancy determine, (1) That when Æternity is said to be, *Quidpiam totum simul*, something wanting succession or flux of parts, as in the memorable Definition of *Boætius*; then is it to be accepted, not *abstractly* for *Duration*, but *Concretely* for the *Divine Substance*, whose Duration is sempiternal. (2) That *Time* and *Eternity* differ each from other, in no other respect, then that Eternity is an infinite Duration, and Time (according to the Vulgar intent of the word) a certain *part* of that infinite Duration, commensing at the Creation, and determining at the Dissolution of the World.

This *Cicero* rightly apprehended, and emphatically expressed, in his sentence, *Tempus est pars quædam Æternitatis, cum alicujus annui, menstrui, diurni, nocturnive spatii certa significatione.* In this respect, Eternity is said to be Duration *Non-principiate* and *Interminable*; which is proper only to *God*: and *Time* is said to be Duration *Principiate* and *Terminable*; which is competent to all *Caduce*, *Mutable*, and *Corruptible Natures*: as also that part of Eternity, which the *Neotericks* by a special idiome name *Ævum*, is Duration *Principiate*, but *Interminable*, which is adscriptive to *Angelical* or *Intellectual Natures*; and to

to the *Rational Soul* of man; for thus we understand that frequent Bipartition of *Eternity* into *à parte ante*, *& à parte post*, invented by the Schoolmen.

Art. 4. The *Platonicks* Definition of Eternity, to be *one Everlasting Now*; not intelligible, and therefore collusive.

These Positions being indisputable, the remaining subject of our præsent Disquisition, is only *Whether the Platonicks spake rationally and intelligibly, when they defined Eternity to be one everlasting* NOW, *or a Duration void of succession, or flux of parts?*

Concerning this grand *Doubt*, we profess, would Truth have connived, we could most willingly have past it by untoucht; because most of our *Christian Doctors* have fully assented unto them in this particular: but, since the convulsion of this their opinion doth stagger no Principle of Faith, or Canonical Document made sacred and established by the Authority of the Church; we shall not deserve Excommunication, nor suffer the expurgatory Spunge of *Rome*, if we quæstion the Congruity of that Definition, and affirm that *No man can understand it.* For, what Wit is so acute and sublime, as to conceive, that a thing can have *Duration*, and that Duration can be as a *point* without *Fusion* and *Continuation* from one moment to another, by intervenient or mediate moments? Easie enough, we confess, it is to conceive, that the *Res durans* is altogether at once, or doth retain the sameness of its Nature, without mutation, diminution, or amission of any Perfection: but that, in this *Perseveration*, there is not many *Nows*, or many *Instants*, of which, compared among themselves, some are *Antecedent*, and others *Consequent*; is to us absolutely incomprehensible.

Nor can we understand, why it may not be good Christian Phrase, to say; God *WAS* in the time of the First Man, and *SHALL* be in the time of the Last: or why it is not more Grammatical and proper for us to say, God Created the World HERETOFORE, and will both destroy and renovate the World HEREAFTER; then, that God doth NOW Create, destroy and renovate.

Art. 5. Their *Assertors* subterfuge, that *Eternity* is *Coexistent* to *Time*; also unintelligible.

To this the Common *Answer* is, that the Reason why these Anthropopathical Phrases are tolerable, is because *Eternity is Coexistent to our Time:* but this is *Ignotum explanare per ignotius*; for the manner of that supposed *Coexistence* hath been never explained, and seemeth laid by till the advent of Elias. That an *Instant*, i. e. what wants succession, can be Coexistent to a *successive* thing; is as manifest an impossibility, as that a *Point*, i. e. what wants Longitude, can be Coexistent or Coextensive to a *Line.* Indeed, They have endeavoured to wave the Difficulty, by subnecting, that the Instant of Eternity is of such peculiar *Eminency*, as that it is Æquivolent to Time though Successive: But as to the Formal Reason, and manner of this peculiar Eminency, they have left it wholly to our Enquiry also. Nor did they bestow one serious thought upon the consideration of it; for had they, doubtless they must have found their Wit at a loss in the Labyrinth of Fancy, and perceived themselves reduced to this Exigent: either that they had fooled themselves in trifling

trifling with words not well underſtood; or that they had præcariouſly uſurped the Quæſtion; or that the ſame Inſtants are in Eternity, that are in our Time, but with ſuch Eminency, that infinitely *more* are contained in Eternity, then in our Time. How much better were it ſaid, that we are Coexiſtent with God; or, that we are exiſtent in a ſmall part of that Duration, in which God infinitely exiſteth? For, while we are, certainly, we cannot imagine *Two* diſtinct Durations; but *one*, which in reſpect to our Nature, that is principiate, mutable, and terminable, doth contain deſignable Terms; and in reſpect of the Divine Nature, which is nonprincipiate, immutable, interminable, hath its Diffuſion or Extenſion infinitely long before, and as long after us. This may receive ample juſtification from that ſpeech of the *Hebrew Poet*, whoſe Inſpirer was the Holy Ghoſt, (*Pſal.* 101.) *Thou ſhalt Change them and they ſhall be changed; but thou, O God! art the ſame forever, and thy years ſhall not fail.* For here YEARS are attributed to God, but not any mutation of Subſtance: ſo that when our years are exhauſted, in a ſhort, or ſpan-like flux of Time, the Glaſs of His Duration is alwayes full. And, therefore, the Expreſſion is only Tropological, when it is ſaid, *that the years of our life make but a Day in the Almanack of Divinity:* for the life of the *Hemerobii* compared to ours of threeſcore years and ten, holds ſome proportion; but the life of *Methuſalem*, compared to the Duration of the Life of our lives, the *Divine Eſſence*, holds none at all. Upon this conſideration, it was more then a Heathen obſervation of *Plutarch* (*in Conſolat. ad Apollon.*) that there is no difference betwixt a long and a brief time, in reſpect of *Eternity:* ſince, as *Simonides*, a thouſand, nay a million of years make but a point, nor ſo much as the leaſt part of a point in the line of infinite Duration.

Art. 6. Our *Eccleſiaſtick Doctors*, taking Sanctuary in the 3 *Exod.* for the authorizing of their doctrine, that the *Præſent* Tenſe is only competent to God, and ſo that *Eternity* is one permanent *Inſtant*, without Fuſion or Succeſſion: not ſecure from the rigour of our Demonſtration.

Convicted thus by Reaſon, our *Doctors* convert to *Scripture*, urging that God (*Exod.* 3.) indicates his Beeing only in the *Præſent* Tenſe, as peculiar to his Eternity, ſaying, *I am, that I am, and I am hath ſent thee* to Moſes. But this Objection admits of a threefold evaſion. (1) The *Hebrew* Text doth not, in that place, uſe the Præſent, but the *Future* Tenſe, *I ſhall be, what I ſhall be, and I ſhall be hath* ſent thee. (2) We can oppoſe many other Texts, which adſcribe to God as well Præterite and Future, as Præſent time; and moſt eminently in the *Revelation*, He is deſcribed, ὁ ὢν, καὶ ὁ ἦν, καὶ ὁ ἐρχόμενος, *He that is, and was, and is to come.* (3) God Himſelf doth frequently enunciate many actions, not that He now doth, but that He hath formerly done, and will do in the future, in that moment of opportunity, which His Wiſdom hath prædetermined. Hence alſo expulſed, They fly to their laſt fortreſs, *viz.*

Art. 7. The *Objective Præſence of all things at once, to the Divine Intellect*; no wayes impugned by our contradiction of the *Doctors* theory.

If Eternity be not one permanet Now, then cannot all things be præſent to God, objectively. But vain is their hope of ſecurity in this alſo. For, many things, if we reſpect the *when* of their exiſtence, have already been, and as many are not yet; but, becauſe the Omniſcience of God pervades as well the darkneſs of *paſt*, as of

præsent Time, and alwayes speculates all things most clearly and distinctly: therefore do we say, that all things are objects to His Opticks, or, that all things are præsent to His Cognition; not that He knows, all things to be præsent at once altogether, but that He hath before Him at once all the diversities of Times, and as perfectly contemplates them Future and Præterite, as Præsent. For, the *Divine* Intellect doth not apprehend Objects, as the *Humane*, one after another, or in a successive and syntactical series; but grasps all things *together* in one entire act of Cognition, and comprehends in one simple intuition whatever hath been, or may be known. And, therefore, our opinion is not at all impugned by that sacred sentence; *All things are open and naked to His eyes, and He calls upon those things, that are not, as if they were.* Hereupon some have, with unpardonable temerity and incogitancy, inferred; that ONCE there was no Time; for in this their very denial, they openly confess, that Time hath ever been: it being all one as if they had said, *There was a Time when there was no Time.*

Art. 8. Nor the *Immutability* of the *Divine Nature*; against *Aristotle.*

Lastly, as the Omniscience of God cannot be indubitated by our persuasion of the *Identity of Eternity and Time*, so neither can His *Immutability*, as *Aristotle* would have it, only for this Reason (forsooth) that Time, or that Duration, which hath successive, and so prior and posterior parts, is the General *Cause* of *Corruption.* For, our præcedent Discourse hath left no room for the intrusion of that futile Objection; insomuch as it rather commonstrateth the *Divine Nature* to be so Constant and Perfect, that in the eternal flux of Time it can know nothing of Innovation or Corruption. Besides, Time, or the succession of Duration, is not the Cause, that induceth Corruption: but the *Native Imbecillity* of compound Natures, invaded and subdued by some *Contrary Agent*; and God is a *Pure*, *Simple*, *Homogeneous* substance, and so not subject to the invasion of any Contrary. Evident it is, therefore, that *Aristotle*, when He urged this Sophism, spoke more like a Poet, then a Philosopher; since Poets only use to give Time the Epithite of *Edax rerum*: nor could He be so absurd, as to dream, that Time was a vast Animal, with sharp teeth, an insatiate appetite, and a belly inexplebile, or an old man armed with a Sithe, as the Poets describe *Saturn*, making κρόνος and χρόνος, *Saturn* and *Time* one and the same thing. For, Time really doth neither Eat nor Mow down any thing; and the *Dissolution* of all Create compound Natures can be imputed to no other Cause, but the Domestick Hostility of their Heterogenieties, or the unceßant intestine warr of their Elements, from whose commixture their Compositions, or Concretions did first result. With this qualification, therefore, we are not angry at that of *Periander*, in *Stobæus*, *Tempus est Causa omnium rerum*: because in the process of Time all things have their origin, state, and declination. In this restrained sense we also tolerate the saying of *Thales Milesius*, quoted by *Laertius*, *Tempus est sapientissimum*: since Time produceth Experience, and Experience Prudence. And that Antitheton of *Pharon* the *Pythagorean*, recited by *Aristotle*; *Tempus est Ineruditissimum*: because in process of Time the Memory of all things is obliterated, and so *oblivion* may well be called the *Hand-maid of Time*, that perpetually follows at the heels of her Mistriss.

Our

Our *Clue* of thoughts concerning *Time* is now wholly unravelled; and though we may not præsume, that we have therewith led the mind of our Reader through all the mysteries of its Nature: yet may we hope, that it may serve as a conduct to those, who have a more ample stock of Learning and Perspicacity for the support and encouragement of their Curiosity; at least that the Attentive and Judicious may easily collect from thence, that we have, upon no Interest but that main one of Verity, withdrawn our assent from the common Doctrine of the Schools, that Eternity is one permanent Now, without Succession, or Priority and Posteriority of Moments. *Art. 9. Coronis.*

The Second Book.

CHAP. I.

The Existence of Atoms, Evicted.

Sect. I.

Art. 1. The right of the Authors Transition from the *Incorporeal* to the *Corporeal* part of Nature: and a series of his subsequent speculations:

Among infinite other hypochondriack Conceits of the *Teutonick* (rather, *Fanatique*) Philosophers, they frequently adscribe a *Dark*, and a *Light* side to God; determining the Essence of *Hell* in the one, and that of *Heaven* in the other. Whether the expression be proper and decent enough to be tolerated; requires the arbitration of only a mean and vulgar judgment. We shall only affirm, that had they accommodated the same to the shadow, or Vicegerent General of God, to *Nature*; their Dialect had been, as more familiar to our capacity, so more worthy our imitation. For, that the INCORPOREAL, and therefore Invisible part of the Universe, the *Inane Space*, may bear the name of the DARK; and the CORPOREAL and visible part of the LUMINOUS side of Nature: seems consentaneous to reason. On the *First*, hath the eye of our Mind been thus long levelled; taking in by collateral and digressive glances the Essential Proprieties of *Place* and *Time*; the one of which is absolutely *Identical*, the other perfectly *Analogous* to *Inanity*: on the *other* we are now to convert it, and with more then common attention, therein to speculate the Catholique *Principles*, *Motions* and *Mutations*, or *Generation* and *Corruption* of BODIES.

All

All Bodies, by an universal Distinction, are either (1) τὰ ἐξ ὧν αἱ Συγκρίσεις, such, from the convention and coalition of which all Concretions result; familiarly called by Physiologists, *Principia, Primordia, Componentia*, but most commonly, *Elementa*, and *Materia Prima*. Or (2) τὰ Συγκρίματα, such as consist of the former coacervated, and coalesced: or such as are composed of many single particles Component. The *Former* were made by *Creation*, and are superiour to Corruption: the *Later* are produced by *Generation*, and reducible by Corruption. The *First* are *Simple* and *Originary*; such as *Plato* intends (*in Phædro*) when he saith, *Principii nullam esse originem, quoniam ex ipso principio oriuntur omnia*: the *other*, *Compound* and *Secondary*; such as *Lucretius* (*lib.* 1.) understands by his *Concilio quæ constant principiorum.*

Art. 2. *Bodies* generally distinguished into *Principles* and *Productions*, with their Scholastick Denominations and proprieties.

What these *First, Simple, Ingenerable, Incorruptible, Universally Component Bodies* are, or to speak in the Dialect of the Vulgar, What is the *General Matter* of all *Concretions* (it is no solœcism in Physiology, to transfer a word abstractly importing a Natural Action upon the thing produced by that action) hath been by more Disputed, then Determined, in all Academies. That there must be some one *Catholique Material Principle*, of which all Concrete Substances are composed; and into which they are again, at length by Corruption resolved: is unanimously confessed by all. And, consequently, that this Matter is *Incorruptible*, or the Term wherein all Dissolution ceaseth; hath been indubitated by none, but those, who, upon a confusion of Geometrical with Physical Maxims, run upon the point of that dangerous Absurdity, *that the infinite division of a real Continuum is possible.* Insomuch therefore, as the Essential reason or Formality of *Corporiety* doth solely consist in *Extensibility*, or the Dimensions of Longitude, Latitude, and Profundity real; as our *Third Chapter* præcedent hath demonstrated, and as the Patriarch of the Schools doth expresly confess (*Natur. Auscult.* 4. *cap.* 3.) and insomuch as nothing can be the *Root* or beginning of Material or Physical Extension, but τὶ ἀδιάφορον, *Aliquid indissolubile*, something so minute and solid, that nothing can be conceived more exiguous and impatible in Nature (for, as the *Radix* of *Mathematick*, or Imaginary Continuity, is a *Point*: so must that of *Physical* or sensible Continuity be a *Body of the smallest Quantity*) such as are the ATOMS of *Democritus, Epicurus*, and other their *Sectators*; and the *Insensible Particles* of *Cartesius*: therefore, from manifest necessity, may we determine, *that no Principle can justly challenge all the Proprieties, or Attributes of the First Universal Matter*, but Σώματα ἀδιάφορα, *Indivisible Bodies*, or *Atoms*. Which fundamental Position clearly to establish by demonstration; is a chief part of our difficult Province: having, for method and prevention of obscurity, first briefly insisted upon their various *Appellations*, with the Etymological relation of each, traced them up to their πήξις, or *Invention*, and evicted their *Existence*.

Art. 3. The right of *Atoms* to the Attributes of the *First Matter*.

(1) As for their various DENOMINATIONS; they naturally reduce themselves to *three General Imports*, bearing a congruous and emphatick respect to their three most eminent *Proprieties*. For,

Art. 4. Their sundry *Appellations* allusive to their three eminent proprieties.

(1) In relation to their *Corporiety*, they are called, τὰ Σώματα, *Bodies*, by way of transcendency: because they are ἄμετοχα κενοῦ, devoyd

devoyd of all *Incorporiety, i.e.* they contain nothing of *Inanity*, as do all Concretions emergent from them, there being in all Compound Bodies more or less of Inanity disseminate among their particles. For which reason, they are also named, πλήρη, *Plena.*

(2) In regard of their affording *Matter* to all Concretions, they are denominated, Ἀρχαὶ, *Principles*, στοιχεῖα, *Elements*, Πρῶτα σώματα, *First Bodies*, Πρῶτα Μεγέθη, *First Magnitudes*, τῶν ὄντων ὕλη, *the Matter of all things*, and Παντοσπερμία, *Genitalia semina rerum*, the seminaries of all productions: because all material things are composed of them. In which concern also, by a Pythagorical Epithite, they are stiled, Μονάδες, *Unities*; because, as all Numbers arise from Unities, so all Compositions from them.

(3) To denote their *Indissolubility*, they are most frequently known by the term, Ἄτομα, and Ἄτομοι, *Atoms*; either because they are incapable of *Section*, as *Isodor*, *Plutarch*, *Servius*, *Budæus*, Scapula, &c. or διὰ τὴν ἄλυσιν στερρότητα, *ob indissolubilem soliditatem*, for their indissoluble solidity. For, all Concrete Bodies, insomuch as they came short of absolute solidity, having somewhat of Inanity intermixt, may be divided, and subdivided until their ultimate resolution into these, their component parts: but Atoms admit of no division below themselves. Wherefore they are usually christned, ἀδιαιρέτα, ἄμερη, *Individual*, *Insectile*, *Impartible*; as likewise, ἀόρατα, λόγῳ θεωρητά, *Invisible*, and *by the mind only perceptible*, Bodies, *i. e.* so exile as no man can conceive a real Exility beyond theirs.

Art. 5. Two vulgarly passant Derivations of the word, *Atom*, exploded.

Hence are we assured, that *Two* vulgarly passant *Derivations* of the word, *Atome*, are ingenuine and extorted. (1) That of *Hesychius*, with too much semblance of approbation mentioned by the Reviver of the great Democritus, *Magnenus*, (*de Atom. disput.* 2. *cap.*2.) which would have it a sprigg of that root, Ἄτμος, *Fumus*; because (forsooth) from all bodies, in their reversion from mixtion to dissolution, their Elements disperse by *Exhalation*: as if this Etymologie were so adæquate and important, as to compensate the defect of an *omicron*, in the second syllable. (2) That embraced not only by many pædantique *Grammarians*, but even acute *Philologers*, who interpret the word *Atomus* to signifie a *Defect of Parts*; as if an Atom were destitute of all *Magnitude*, or no other then a mere Mathematical Point: when, indeed, the *Nomenclator* had his eye fixt only on their *Solidity*, Hardness, or Impatibility, which is such, as excludes all possibility of Fraction, Section, Division. Thus much *Epicurus* himself expresseth, in most perspicuous and unpervertible terms (*apud Plutarch.* 1. *placit.* 3.) thus; *Dicitur Atomus, non quòd minima sit, vel instar puncti, sed quod non possit dividi; cùm sit patiendi incapax, & inanis expers.* And *Galen* (1 *de Elem.*) recounting their doctrine, who affirmed the Principles of all Bodies to be Atoms, saith of *Epicurus*, *Fecit Atomos*, ἀθραύστους ὑπὸ σκληρότητος, He made them Infrangible in respect to their *solidity*.

(2) Con-

(2) Concerning their INVENTION; if we reflect upon them as *in Re*, before their reception of any constant Denomination; we have the tradition not only of *Possidonius* the Stoick, related by *Empiricus* (*adverf. Physic. lib. ib.*) but also of *Strabo*, to assure the honour thereof upon one *Moschus*, a *Phænician*, who flourished not long before the ruine of *Troy* by the Græcians. Allowing this for Authentique, we have some cause to judge *Magnenus* to have been too favourable to his Grand Master, *Democritus*, when (*in testimon. de Democrito. pag.* 32.) He enricheth his Panegyrick of him with, *Effluvia Corporum Atomosque comperit, & invexit omnium primus: ex Laertio quod unum tanti apud me est, ut congestas omnium Philosophorum laudes vel exæquet vel superet.* Besides, to do *Laertius* right, He finds *Leucippus*, not *Democritus*, to have been the Founder of this incomparable Hypothesis: as his records lye open to testifie (*in vita Leucippi.*) But, if we reflect upon them only as *in Nomine*, enquiring who was their Godfather, that imposed the most convenient name, *Atoms*, upon them; we need not any more ancient, or faithful monuments to silence all competition about that honour, then those of *Theodoret*: who rightly sets the Laurel on the deserving front of *Epicurus*, in this text; Ἐπίκουρος ὁ Νεοκλέους, τὰ ὑπ' ἐκείνων νασὰ, καὶ ἀδιαίρητα δὴ καλήσας, Ἄτομα προσηγόρευσεν; *Epicurus, Neoclis filius*, dicta illis (meaning *Democritus* and *Metrodorus Chius*) *Nasta & Adiareta, appellavit Atomos.* We are not ignorant, that *Sidonius Apollinaris* (*carmin.* 15.) adscribes the imposition of this name, to *Archelaus* in these Verses:

Art. 6. Who their Inventor: and who their Nomenclator.

Post hos, Archelaus divina, mente paratam
Concipit hanc molem, confectam partibus illis,
Quos Atomos vocat, ipse leveis, &c.

But how unjustly, even S. *Augustine* (8. *de Civit. Dei, cap* 3.) sufficiently declares; saying, that *Archelaus* deduced all things, *non ex Atomis, sed ex Particulis dissimilibus.* And therefore, though we may not file up the first Discovery of this noble Principle, Atoms (of all others, hitherto excogitated, the most verisimilous, because most sufficient to the solution of all Natures Phænomena) among those many benefits, which the Commonweal of Philosophy owes to the bounteous Wit of *Epicurus*: yet hath his sagacity in accommodating them with so perfectly congruous an Appellation, and successful industry in advancing and refining their Theory, in the General, worthily entituled him to the homage of a grateful Estimation equal to that, which the merit of their *Inventor* claims.

(3) Concerning their EXISTENCE; that there are such Things, as Atoms, or Insectile Bodies, *in Rerum Natura*; cannot be long doubted by any judicious man, who shall thus reason with himself.

Art. 7. Their *Existence* demonstrated.

(1) *Nature can produce Nothing out of Nothing; nor reduce any thing to Nothing:* is an Axiome, whose tranquility was never yet disturbed, no not by those who have invaded the Certitude of even First Notions, and accused Geometry of delusion. If so; there must be some *Common Stock*, or an Universal Something, *Ingenerable*, and *Incorruptible*, of which being præexistent, all things are Generated, and into which being

being indissoluble, all things are, at the period of their duration, again resolved.

Art. 8. That Nature, in her dissolution of Concretions, doth descend to *insensible* particles.

That Nature doth dissolve Bodies into exceeding minute, or insensible particles; Her self doth undeniably manifest, as well in the *Nutrition* of *Animate* (their Aliment being volatilized into so many insensible particles, as those whereof the Body nourished doth consist; otherwise there could be no General Apposition, Accretion, Assimilation) as the *Incineration* of *Dead* Bodies. Which ground *Des Cartes* rightly apprehended to be so firm and evident, that he thought the existence of his Insensible Particles sufficiently demonstrable from thence. *Quis dubitare potest* (saith He) *quin multa Corpora sint tam minuta, ut ea nullo sensu deprehendamus, si tantum consideret, quidnam singulis horis adjiciatur iis quæ lentè augentur, vel quid detrahatur ex iis quæ sensim minuuntur? Crescit enim arbor quotidiè, nec potest intelligi majorem illam reddi quàm priùs fuit, nisi simul intelligatur aliquod corpus eidem adjungi. Quis autèm unquam sensu deprehenderit, quænam sint illa corpuscula, quæ in una die arbori crescenti accesserunt, &c.* (*princip. Philos. part.*4.*articul.*201.)

Art. 9. That she cannot run on to *Infinity*.

That she cannot in her Dissolution of Bodies, proceed to *Infinity*, but must consist in some *definite Term*, or *extreme*, the lowest of *Physical Quantity*; is demonstrable from hence, that *every real Magnitude is uncapable of interminable Division*. For, since to an infinite process is required an infinite Time; she could never Generate any thing New, because the old would require an infinite time and process to their Dissolution. Convicted by this apodictical Argument, *Aristotle* (1 *Phys.*9.) detesting the odious Absurdity of (εἰς ἄπειρον εἶναι) running on to Infinity; solemnly concludes (ἀνάγκη δὴ εἶναι) that there must be an Extreme Matter, wherein all Exolution is terminated: only herein He recedes from the supposition of *Democritus*, *Epicurus*, and other Patrons of the same Doctrine, that they terminated all Exolution in the *Insectility* of *Atoms*; but He describes no such Extreme, or point of Consistence, his *Materia Prima* being stated rather *Potential*, then *Actual*, and absolutely devoid of all *Quantity*; then which we know no more open and inexcusable a *Contradiction*. Again, if the Exolution of Bodies were not Definite, and that Nature knowing no *nè ultra*, did progress to *Adnihilation*: then must it inevitably follow, that the Matter of all things, that have been formerly, is totally Adnihilated; and the matter of all things now Existent, was educed out of Nothing. Two most intolerable Absurdities; since *Adnihilation* and *Creation* are terms not to be found in the Dictionary of *Nature*, but proper only to *Omnipotence*: nor is there any sober man, who doth not understand the Common Material of Things to be constantly the *same*, through the whole flux of Time, or the duration of the World; so as that from the Creation thereof by the *Fiat* of God, no one particle of it can perish, or vanish into Nothing, until the total Dissolution of Nature, by the same Metaphysical power; nor any one particle of new matter be superadded thereto, without miracle. The Energy of Nature is definite and præscribed: nor is she Commissioned with any other Efficacy, then what extends to the moulding of *Old Matter* into *New Figures*; and so, the noblest Attribute we can allow her, is that of a *Translator*.

Art. 10. But must consist in *Atoms*, the *Term* of Exsolubility.

Now, to extract the spirit of all this, since there must be an Extreme, or ultimate

ultimate Term of Exolubility, beyond which can be progress; since this Term can be conceived no other but the lowest degree of Physical Quantity; and since, beyond the Insectility of Atoms, no Quantity Physical can be granted: what can the genuine Consequent be, but that *in Nature there are extremly minute Bodies*, Ἄτομα καὶ ἀμετάβλητα, *Indivisible* and *Immutable?*

(2) For Confirmation; as in the Universe there is, *Aliquid Inane*, something so purely *Inane*, as that it is absolutely devoyd of all Corporiety: so also must there be *Aliquid Corporeum*, somewhat so purely *Corporeal*, or *solid*, as to be perfectly devoyd of all Inanity; to which peculiar solidity nothing but *Atoms*, in regard of their *Indivisibility*, can prætend: therefore is their *Existence* to be confessed. This Reason *Lucretius* most elegantly thus urgeth;

Art. 11. A second *Argument* of their Existence, drawn from that of their Antitheton, *Inanity*.

> *Tum porrò, si nil esset, quod* INANE *vacaret,*
> *Omne foret solidum; nisi contrà* CORPORA *cæca*
> *Essent, quæ loca complerent quæcunque tenerent,*
> *Omne quod est spatium, Vacuum constaret Inane, &c.* Lib. 1.

(3) Evident it is to sense, that in the World are two sorts of Bodies, *Soft* and *Hard*; now, if we assume the Principles of all things to be exquisitely Hard, or Solid; then do we admit the production of not only Hard, but also of soft Bodies to be possible, because softness may arise to a Concretion of Hard Principles, from the Intermistion of Inanity: but, if we assume soft Principles, then do we exclude all possibility of the production of Hard Bodies, that Solidity, which is the Fundament of Hardness, being substracted: Therefore is the Concession of *Atoms* necessary.

Art. 12. A third, hinted from the impossibility of the Production of *Hard* Bodies, from any other Principle.

(4) Nature is perpetually *Constant* in all her specifical Operations, as in her Production and Promotion of Animals to the determinate periods of their Increment, Stature, Vigour, and Duration; and, more evidently, in the impression of those marks, whereby each species is discriminated from other. Now, to what Cause can this Her Constancy be, with greater probability, referred, then to this, that her *Materials* are *Certain*, *Constant*, and inobnoxious to Dissolution, and consequently to mutation: and such are *Atoms* præsumed to be? *Ergo*, they are *Existent*.

Art. 13. A *Fourth*, from the *Constancy* of Nature in the specification and Determinate Periods of her Generations.

CHAP. II.

No Physical Continuum, infinitely Divisible.

SECT. I.

Art. 1. The Cognation of this Theorem, to the Argument of the immediately præcedent Chapter.

THE Grand Base on which the whole Fabrick of the Atomists, *i. e.* our Physiology is supported, confesseth it self to be this; that Nature cannot extend her Dissolution of Bodies beyond τὶ στερέον καὶ ἀδιάλυτον, somewhat that is *Firm* and *Inexsoluble.* And the rock on which that adamantine Base is fixt, is soon understood to be this; that *the Parts of no Physical Continuum, or Magnitude, are subdivisible to Infinity.* The *Former*, we conceive so clearly comprobated by Reasons of evidence and certitude equal to that of the most perfect Demonstration in Geometry, that to suspect its admission for an imprægnable Verity, by all, who have not, by a sacramental subscription of *Aristotles* Infallibility, abjured the ingenious Liberty of estimating Philosophical Fundaments more by the moments of Verisimility; then the specious Commendums of Authority; were no less then implicitely to disparage the Capacity of our Reader, by supposing Him an incompetent judge of their importance and validity. And that the *Other* is equally noble in its alliance to Truth, and so secure from subversion by the minds of the acutest Sophistry, that may oppose it; is the necessary Theorem of this præsent *Exercitation.*

Art. 2. Magnitude divisible by a continued progress through parts either *Proportional*, or *Aliquotal.*

To usher in this Verity with the greater splendor, we are required to advertise

(1) That Philosophers have instituted two distinct Methods, for the regular Division of Magnitude. For, their Divisions are continued by a progression through Parts either (1) PROPORTIONAL; which is when a Physical Continuum is divided into two parts, and each of those parts is subdivided again into two more, and each of those into two more; or when the whole of any magnitude is divided into 10 equal parts

parts, and each of those into 10 more, and each of those into 10 more; and so forward, observing the same decimal proportions through the whole division: or (2) ALIQUOTAL; *i.e.* when a Continuum is divided into such parts, as being divers times repeated, are æquated to the whole, or into so many parts as seem convenient to the Divisor, provided they hold equal proportions among themselves, whether they be Miles, Furlongs, Fathoms, Feet, Digits, &c. Which Distinction *Aristotle* seems to allude unto, when he declares (3.*physic*.7.) that the Difference betwixt Magnitude and Number doth consist in this, that by the Division of *Numbers* we arrive at last, ὅτι τὸ ἐλάχιστον, *ad Minimum*, at the *Least*; but of *Magnitude*, ὅτι τὸ ἔλαττον, *ad Minus*, only to a *Less*.

(2) That when *Democritus*, *Epicurus*, and other Ancients of the same *Antistoical* Faction, treating of the Division of Magnitude, determine it ὅτι τ ἔλαττον; they did chiefly intend that Methodical Division, which is made *in partes Proportionales*; insomuch as every part made by a second division must be less then that made by a first.

Art. 3. The use of that Distinction in the præsent.

The Demonstration.

If in a Finite Body, the number of Parts, into which it may be divided, be not Finite also; then must the Parts comprehended therein be really Infinite: and, upon Consequence, the whole Composition resulting from their Commixture, be really Infinite; which is repugnant to the supposition.

Art. 4. The verity of the *Thesis*, demonstrated.

So perfectly Apodictical, and so inoppugnably victorious, is this single Argument, that there needs no other to the justification of our instant Cause: nor can the most obstinate and refractory Champion of the Peripateticks, refuse to surrender his assent thereto, without being reduced to a most dishonourable exigent. For, He must allow either that the whole of any Body is something besides, or distinct from the Aggeries, or Mass of Parts, of which it is composed: or, that all the Parts, together taken, are somewhat greater then the whole amassed by their convention and coalescence. If so; there must be as many parts in a grain of Mustard seed, as in the whole Terrestrial Globe: since in either is supposed an equal Inexhauribility; which is contrary to the First Notion of *Euclid*, *Totum est majus sua parte.* And if any mans skull be so soft, as to admit a durable impression of an opinion so openly self-contradictory, as this, that *the Whole is less then its Parts*; we judge him a fit Scholer for *Chrysippus*, who blusht not publiquely to affirm, that one drop of Wine was capable of commistion with every particle of the Ocean, nay, diffusive enough to extend to an union with every particle of the Universe, were it 100000 times greater, then now it is. Nor, need we despair to make him swear, that *Arcesilas* did not jeer the Disciples of *Zeno*, when he exemplified the inexhaurible division of Magnitude, in a mans Thigh, amputated, putrified, and cast into the Sea; ironically affirming the parts thereof so infinitely subdivisible, that it might be incorporated *per minimas*, to every particle of Water therein; and consequently, that not only *Antigonus* Navy might sail at large through the thigh, but also

Art. 5. Two detestable *Absurdities*, inseparable from the position of Infinite parts in a *Continuum*.

alſo that *Xerxes* thouſand two hundred ſhips might freely maintain a Naval fight with 300 Gallies of the Greeks, in the compaſs of its diſperſed parts. We deny not, but *Zeno's* Argument againſt Motion, grounded on the ſuppoſition of interminable Partibility in Magnitude, is too hard and full of Knots, to be undone by the teeth of common reaſon: yet who hath been ſo ſuperlatively ſtupid, as to prefer the mere plauſibility thereof to the contrary Demonſtration of his ſenſe, and thereupon infer a belief, that there is no Motion in the World? What Credulity is there ſo eaſie, as to entertain a conceit, that one granule of ſand (a thing of very ſmall circumſcription) doth contain ſo great a number of parts, as that it may be divided into a thouſand millions of Myriads; and each of thoſe parts be ſubdivided into a thouſand millions of Myriads; and each of thoſe be redivided into as many; and each of thoſe into as many: ſo as that it is impoſſible, by multiplications of Diviſions, ever to arrive at parts ſo extremely ſmall, as that none can be ſmaller; though the ſubdiviſions be repeated every moment, not only in an hour, a day, a month, or a year, but a thouſand millions of Myriads of years? Or, What Hypochondriack hath been ſo wild in Phanſie, as to conceive that the vaſt maſs of the World may not be divided into more parts then the Foot of a Handworm, a thing ſo minute as if made only to experiment the perfection of an Engyſcope? And yet this muſt not be granted, if we hearken to the ſpels of *Zeno* and the Stoicks; who contend for the Diviſibility of every the ſmalleſt quantity into infinite parts: ſince, into how many parts ſoever the World be divided, as many are aſſumable in the Foot of a Handworm, the parts of this being no leſs inexhauſtible, nor more terminable by any continued diviſion, then the parts of that, according to the ſuppoſition of Infinitude. And, hereon may we ſafely conclude, that albeit the Arguments alledged in defence of Infinite Diviſibility of every Phyſical Continuum, were (as not a few, nor obſcure Clerks have reputed them) abſolutely indiſſoluble: yet notwithſtanding, ſince we have the plain Certificate of not only our Reaſon, but undeluded ſenſe alſo to evidence the Contrary, ought we to more then ſuſpect them of ſecret Fallacy and Colluſion; it being a rule, worthy the reputation of a Firſt Notion, that in the examination of thoſe Phyſical Theorems, whoſe Verity, or Falſity is determinable by the ſincere judicature of the ſenſe, we ought to appeal to no other Criterion, but to acquieſce in the Certification thereof; eſpecially where is no Refragation, or Diſſent of Reaſon.

Notwithſtanding the manifeſt neceſſity of this apodictical Truth, yet have there been many *Sophiſms* framed, upon deſign to evade it: among which we find only *Two*, whoſe plauſibility and popular approbation ſeem to præſcribe them to our præſent notice.

Art. 6. *Ariſtotles* ſubterfuge of Infinitude *Potential.*;

The *Firſt* is that famous one of *Ariſtotle (de inſecabil. lineis) Non creari propterea infinitum actu ex hujuſmodi partibus infinitis, quoniam tales partes non actu, ſed poteſtate duntaxat infinitæ ſunt; adeo proindè ut creent ſolùm infinitum poteſtate, quod idem ſit actu finitum:* that the diviſion of a finite body into infinite parts doth not make it actually infinite, becauſe the parts are not actually, but only potentially infinite; ſo as they render it infinitely diviſible only potentially, while it ſtill remains actually Finite.

The

The Collusion of this Distinction is not deeply concealed. For, every Continuum hath either *no* parts *in actu*, or *infinite* parts *in actu*. Since, if by parts *in actu*, we understand those that are *actually divided*: then hath not any Continuum so much as two or three parts; the supposed *Continuity* excluding all *Division*. And if we intend, that a Continuum hath therefore two parts actually, because it is *capable* of division into two parts actually: then is it necessary, that we allow a Continuum to have parts actually infinite, because we presume it capable of division into infinite parts actually; which is contradictory to *Aristotle*. Nor can any of his *Defendants* excuse the consequence by saying; that the Division is never finishable, or terminable, and that his sense is only this, that no Continuum can ever be divided into so many parts, as that it may not be again divided into more, and those by redivision into more, and so forward without end. Since, as in a Continuum two parts are not denyed to exist, though it be never divided into those two parts: so likewise are not infinite parts denied to exist therein, though it be never really divisible into infinite parts. Otherwise, we demand, since by those requisite divisions and subdivisions *usque ad infinitum*, still more and more actuall parts are discovered; can you conceive those parts, which may be discovered to be of any *Determinate Number*, or not? If you take the *Affirm.* then will not there be parts enough to maintain the division to infinity: if the *Negat.* then must the parts be actually infinite. For, how can a Continuum be superior to final exhaustion, unless in this respect, that it contains infinite parts, *i. e.* such whose Infinity makes it Inexhaustible. Because, as those parts, which are deduced from a Continuum, must be præexistent therein before deduction (else whence are they deduceable?) so also must those, which yet remain deduceable, be actually existent therein, otherwise they are not deducible from it. For, Parts are then Infinite, when more and more inexhaustibly, or without end, are conceded Deducible.

Art. 7. Found openly *Collusive.*

The other, with unpardonable confidence insisted on by the *Stoicks*, is this; *Continuum non evadere infinitum; quoniam illud propriè resultat non ex Proportionalibus, sed ex Aliquotis partibus, quas constat esse Definitas, cùm inter extrema Corporis versentur:* that [by admitting an infinity of parts in a Finite Continuum] a Continuum doth not become infinite; because that results properly not from *Proportional*, but *Aliquotal* parts, which are therefore confess'd to be *Definite*, because they relate only to the *Extremes* of a Body.

Art. 8. A second subterfuge of the *Stoick*;

First, this subterfuge is a mere *Lusus Verborum*, sounding nought at all in the ears of Reason. For since every thing doth consist of those parts, into which it may be at last resolved; because every Continuum is at last resolved into, therefore must it consist of Proportional Parts. Again, since every one of Aliquotal parts is Continuate, each of them may be divided into as many Aliquotal parts, as the whole Continuum was first divided into, and so upwards infinitely: so as at length the Division must revert into Proportional Parts, and the Difficulty remain the same.

Art. 9. Manifestly dissentaneous to Reason.

SECT.

Sect. II.

THe impossibility of Dividing a Physical Continuum into parts interminably subdivisible, being thus amply Demonstrated; and the Sophistry of the most specious Recesses, invented to assist the Contrary opinion, clearly detected: the residue of this Chapter belongs to our Vindication of the same Thesis from the guilt of those *Absurdities* and *Incongruities*, which the Dissenting Faction hath charged upon it.

Art. 1. The *Absurdities*, by *Empiricus*, charged upon the supposition of only Finite parts in a Continuum.

Empiricus, with great Virulency of language inveighing against the Patrons of Atoms, accuseth them of subverting all Local Motion, by supposing that not only Place and Time, but also Natural Quantity indivisible beyond Insectile Parts. To make this the more credible, He Objects (1) That if we assume a Line, consisting of nine Insectils, and imagine two insectile Bodies to be moved, with equal velocity, from the opposite extremes thereof toward the middle; it must be, to their mutual occurse, and convention in the middle, necessary that both possess the median part of the median, or Fifth Insectile place (there being no cause, why one should possess it more then the other) when yet both the Places and Bodies therein moved, are præsumed Insectile, *i. e.* without parts. (2) That all Bodies must be moved with equal celerity; for, the pace of the Sun and that of a Snail must be æquivelox, if both move through an insectile space, in an insectile Time. (3) That, if many Concentrical Circles be described by the circumduction of one Rule, defixed upon one of its extremes, as upon a Centre; since they are all delineated at one and the same time, and some are greater then others: it must follow, that unequal portions of Circles are described in the same individual point of Time, and consequently that an Insectile of an Interior Circle must be æquated to a sectile of an Exterior.

Art. 2. The sundry *Incongruities* & *Inconsistences*, by the Modern *Anti-Democritans*, imputed to the supposition of *Insectility*.

To these our Modern *Anti-Epicureans* have superadded many other Ἀσύστατα, or *Inconcistencies*, as dependent on the position of *Insectility*. *viz.* (1) That a Line of unæqual Insectiles, suppose of 3. 5. 9. or 11. cannot be divided into two equal halfs: when yet, that any Line whatever may be exactly bipartited, is demonstrable to sense. (2) That a less line cannot be divided into so many parts, as a Greater: though the Contrary be concordant to the maximes of Geometry. (3) That though lines drawn betwixt all the points of the Leggs of an Isoscelis Triangle, parallel to its Base, are less then its Base; yet will they be found greater: because, supposing the Base to be of five points, and the Leggs of 10; it must follow, that the least Line, or the nearest to the Vertex, doth consist of only two points, the second of 3, the third of 4, the fourth of 5, the fifth of 6, the sixth of 7, the seventh of 8, and the greatest, or nearest to the Base, of 9; then which nothing can be more absurd. (4) That the Diagone of a Quadrate would be commensurable in longitude with the side thereof: one and the same point being the measure common to both; though the Contrary is demonstrated by *Euclid.* (5) That the same Diagone of a Quadrate could not be greater then, but exactly adæquate to the

the side thereof: because each of all its points must be possessed by just so many, nor more nor fewer lines, then may be drawn betwixt the points of the opposite sides; which is highly absurd. (6) That, with the danger of no less absurdity, would not a semicircle be greater then its Diametre; since to every point in the semicircle there would respond another in the Diametre, and there would be in both as many points, on which as many perpendicular Lines, deduced from them, might be incident. (7) That, according to the supposition of Insectility, of many Concentrick Circles the Exterior would not be greater then the Interior; insomuch as all the Lines drawn from all the points of it toward the Centre, must pass through as many points of the other. Many other Exceptions lye against our Insectility; but being they are of the same Nature with these, rather Mathematical, then Physical, and that one common solution will serve them all: we may not abuse our leasure in their recitation.

Art. 2. The full *Derogation* of them all together, by one single Response; that the *minimum* of Atomists is not Mathematical, but *Physical*, contrary to their præsumption.

That there have been hot and scarce ingenious Altercations among the gravest and leading Philosophers, in all ages; and even about those Arguments, which wear the proper Characters of Truth fairly engraven on their Fronts: can be esteemed no wonder; because the general custom of men to speculate the Fabrick of Nature through the deceivable Glass of Authority, doth amply solve it. But, that so many Examples of Sagacity and Disquisition, as have condemned the Hypothesis of Atoms, should think their Choler against the Patrons of it excusable only by the allegation of these light and impertinent Exceptions: cannot be denyed the reputation of a Wonder, and such a one as no plea, but an ambitious Affectation of extraordinary subtilty in the invention of Sophisms (wherein Fallacy is so neatly disguised in the amiable habit of right Reason, as to be charming enough to impose upon the incircumspection of common Credulity, and cast disparagement upon the most noble and evident Fundamentals.) can palliate. For, certainly, They could not be ignorant, that they corrupted the state of the Quæstion; the *Minimum*, or *Insectile* of *Atomists*, being not *Mathematicum*, but *Physicum*, and of a far different nature from that Least of Quantity, which Geometricians imagining only, denominate a *Point*. And therefore, what *Cicero* (1. *de finib.*) said against *Epicurus*; *Non esse ne illud quidem Physici, credere aliquid esse minimum:* may be justly converted into, *Esse præsertim Physici, naturale quoddam minimum asserere*; since Nature in her Exolutions cannot progress to infinity. We say, *Physici*; because it is the *Naturalist*, whose enquiries are confined to sensible objects, and such as are really Existent in Nature: nor is He at all concerned, to use those *Abstractions* (as they are termed) from *Matter*; the Mathematician being the only He, who cannot, with safety to his Principles, admit the Tenet of Insectility, or Term of Divisibility. For to Him only is it requisite, to suppose and speculate Quantity abstract from Corporiety; it being evident, that if He did allow any Magnitude divisible only into Individuals, or that the number of possible parts, or points in a Continuum, were definite: then could he not erect Geometrical, or exquisite Demonstrations. And hence only is it, that He supposeth an Infinitude of points in every the least Continuum, or (in his own phrase) that every Continuum is div sible into parts infinitely subdivisible: not that He doth, or can really understand it so; but that many Convenient Conclusions, and no considerable Incongruities, follow upon the Concession thereof. This considered, we need no other evidence, that

that all the former Objections, accumulated upon *Epicurus* by the malitious Sophistry of *Empiricus* and others, concern only the *Mathematicians*, not the *Physiologist*, who is a stranger to their supposition of interminable Divisibility.

Art. 4. A seeming *Dilemma* of the Adversary, expeditely evaded.

If this *Response* prævail not, and that we must yet sustain this seeming Dilemma; Either the suppositions of the Mathematicians are *True* or *False*: if *true*, then doth their verity hold, when accommodated to Physical Theorems, by the assumption of any sensible Continuum, or real Magnitude; if *false*, then are not the Conclusions Necessary, that are deduced from them, but the contray is apparent in their demonstrations; Therefore, &c. Our *Expedient* is, that, though we should concede those suppositions to be False, yet may they afford true and necessary Conclusions: every Novice in Logick well knowing how to extract undeniable Conclusions out of most false propositions, only supposed true, as may be Instanced in this Syllogism. *Omnes arbores sunt in cœlo* (that's false) *sed omnia sydera sunt Arbores* (that's false) *Ergo, omnia sydera sunt in cœlo* (that's indisputable). Besides, 'tis evident, that of those many *Hypotheses* celebrated by *Astronomers*, either no one is absolutely true, or all except one, are false: yet Experience assures, that from all, at least from most of them the Motions of Cœlestial Bodies may be described, and respective Calculations instituted with equal *Certude*.

Digression.

Art. 5. A *Digression*, stating and determining, that notable Quæstion, Whether *Geometrical Demonstrations may be conveniently transferred to Physical or sensible Quantity?*

Here, because our Reader cannot but perceive us occasionally fallen into the mouth of that eminent Quæstion; *An liceat in materiam physicam, sive sensibilem, transferre Geometricas Demonstrationes?* Whether it be convenient to transfer Geometrical Demonstrations to Physical or sensible Quantity? Since they, who accept the *Negative*, seem to adnihilate the use of Geometry: we need not deprecate his impatience, though we digress so long, as to præsent him the summary of our thoughts concerning it.

First, we conceive it not justifiable, alwayes to expect the eviction of Physical Theorems; by Geometrical Demonstrations. This may be authorized from hence, that Geometricians themselves, when they fall upon the theory of those parts of the Mathematicks, which are *Physicomathematical*, or of a mixt and complex Consideration, are frequently necessitated to convert to suppositions, not only different from, but directly and openly repugnant to their own proper and establisht maxims. Thus, in Opticks, *Euclid* concedes a *Least Angle*; and *Vitellio* admits a *Least Light*, such as being once understood to be divided, hath no longer the act of Light, *i. e.* wholly disappears: which is no less, then in Opticks to allow a Term, or point of Consistence to the Division of Quantity, which yet in Geometry they hold capable of an infinite process. We are provided of a most pertinent Example, for the illustration of the whole matter. The *Geometrician* Demonstrateth the Division of a Line into two equal segments, to be a thing not only possible, but most easie: and yet cannot the *Physiologist* be induced to swallow it, as really performable.

For

For He considers (1) That the superfice of no body can be so exactly smooth and polite, as to be devoyd of all unevenes or asperity, every common Microscope discovering numerous inæqualities in the surface of even the best cut Diamonds, and the finest Chrystal, Bodies, whose Tralucency sufficiently confesseth them to be exceeding polite: and consequently, that there is assumable thereon no Line so perfectly uniform, as not to be made unequal by many *Valleculæ* and *Monticulæ*, small pits and protuberances frequently interjacent. (2) That the Edge of no Dissecting Instrument can be so acute, as not to draw a line of some Latitude. (3) That should the edge of the acutest Rasor be laid on the foot of a Handworm, which may be effected by the advantage of a good Magnifying Glass, and a steady hand: yet is that composed of many Myriads of Atoms, or insensible particles of the First universal Matter. And thence Concludes that no real Line drawn upon the superfice of any the smoothest Body, can be practically divided into two Halfs, so exactly, as that the section shall be in that part, which is truly the median to both extremes. Since, that part, which appears, to the sense, to be the median, and is most exiguous; doth yet consist of so many Myriads of particles, as that though the edge of the Rasor be imposed by many Myriads of particles aside of that, which is truly in the middle, yet will it seem to the eye still to be one and the same. This duely perpended, we have no cause to fear the *section of an Atome*, though the edge of a knife were imposed directly upon it: Since the edge must be gross and blunt, if compared to the exility of an Atome: so that we may allow it to divide an Assembly, or Heap of Atoms, but never to cut a single one.

Secondly, We judge it expedient in some cases to accommodate suppositions Geometrical to Subjects merely Physical; but to this end only, that we may thereby acquire *majorem ἀκρίβειαν*, a greater degree of *Acutenes*, or advance our speculations to more Exactnes. Thus the soul of the Mathematicks, *Archimed*, (*de Arenarum num.*) supposed the Diametre of a grain of Poppy seed to consist of 10000 particles; not that He conceived that any Art could really discern so vast a multitude of parts in a body of so minute circumscription: but that, by transferring the same reason to another body of larger dimensions, He might attain the certitude of his Proposition by so much the nearer, by how much the less he might have erred by neglecting one of those many particles. Thus also is it the custom of Geometricians, in order to their exactnes in Calculations, to imagine the Semidiametre, or Radius of any Circle, divided into many Myriads of Parts; not that so many parts can be really distinguished in any Radius, but that, when comparation is made betwixt the Radius, and other right lines, which in parts Aliquotal, or such as are expressed by whole numbers, do not exactly respond thereunto, particles may be found out so exile, as though one, or the fraction of one of them be neglected yet can no sensible Error ensue thereupon. And this (in a word) seems to be the true and only Cause, why Mathematicians constantly suppose every Continuum to consist of Infinite parts: not that they can, or ought to understand it to be Really so; but that they may conserve to themselves a liberty of insensible Latitude, by subdividing each division of Parts into so many as they please; For, they well know, that the Physiologist is in the right, when He admits no Infinity, but only an Innumerability of parts in natuaral Continuum. Lastly, if these Reasons appear not weighty enough to

counterpoise the Contrary Persuasion; we can aggravate them with a Grain of noble Authority. For, no meaner a man then *Plato*, who seems to have understood Geometry as well as the Ægyptian *Theuth*, the supposed Inventor thereof (*vide Platon. in Phædro*) and to have honoured it much more in a solemn Panegyrick (*9. dialog. de Rep.*) sharply reprehends *Eudoxus*, *Archytas*, *Menæchonus*, &c. for their errour in endeavouring to adjust Geometrical speculations to sensible objects: subnecting in positive termes, that (διαφθείρεσθαι τὸ γεωμετρίας ἀγαθὸν) thereby the good of Geometry was corrupted. (*Lege Marsil. Ficin. in Compend. Timæi. cap.* 19.)

CHAP.

CHAP. III.

Atoms, the First and Universal Matter.

SECT. I.

NO man so fit to receive and retain the impressions of *Truth*, as He, who hath his Virgin mind totally dispossessed of *Præjudice*: and no *Thesis* hath ever, since the Envy of *Aristotle* was so hot, as to burn the Volumes of *Democritus* and most of the Elder Philosophers, which might have conserved its lustre, been more Eclipsed with a præsumption of sundry *Incongruities*, then this noble one, that *Atoms are the First and Catholique Principle of Bodies.* Requisite it is therefore that thisChapter have, *Janus* like, two faces: *one* to look backward on those *Impediments* to its general admission, the *Inconsistences* charged upon, and sundry *Difficulties* supposed inseparable from it; the *other* to look forward at the plenary *Remonstrance* of its *Verity.*

Art. 1. The introduction, hinting the two general assumptions of the Chapter.

Superbissimo furore ambitiosus nominis Aristoteles, in Philosophorum Principes est debacchatus, unoque incendio congestas triginta sex seculis tot sapientiæ divitias absumpsit; & si quæ voluit superesse funeri, ea omnium ludibrio, dicteriisque lacessenda tradidit posteris, dum in optimorum bona invectus, abscissis perditisque sapientiæ statuarum capitibus, suum imposuit singulis: ut Magnenas, in Democrit. Script. Elench. ex Plinio in præfat. ad D. Vespanianum Imp.

In obedience to this necessity, therefore, we advertise, *first*; that it hath proved of no small disadvantage to the promotion of the Doctrine of Atoms, that the Founders thereof have been accused of laying it down for a main Fundamental, *that there are two Principles of all things in the Universe*, BODIE and INANITY; importing the necessary Concurrence of the *Inane Space* to the constitution of Bodies complex, as well as of *Atoms.* This Absurdity hath been unworthily charged upon *Epicurus* by *Plutarch*, in these words; *Principia esse Epicuro Infinitatem & Inane:* and upon *Leucippus* and *Democritus* by *Aristotle* (1. *Metaphys.*4.) in these; *Plenum & Inane Elementa dicunt.*

Art. 2. *Democritus* & *Epicurus* vindicated from the absurd admission of *Inanity* to be one Principle of Generables.

To vindicate these *Mirrors* of Science from so dishonourable an Imputation, we plead; that though they held the Universe to consist of two *General Parts*, *Atoms* and *Vacuity*: yet did not they, therefore, affirm, that

all things were composed of those two, as *Elementary* Principles. That which imposed upon their *Accusers* judgment, was this, that supposing *Atoms* and the *Inane Space* to be *Ingenite* and *Incorruptible*, they conceived the whole of Nature to arise from them, as from its two universal Parts; but never dreamt so wild an Alogy, as that all *Concretions*, that are produced by Generation, and subject to destruction by Corruption, must derive their Consistence from those two, in the capacity of Elements, or *Componentia.* For, albeit in some latitude and liberty of sense, they may be conceded Elements, or Principles of the Universe: yet doth it not naturally follow, that therefore they must be equal Principles, or Elements of *Generables*; since Atoms only fulfill that title, the Inane Space affording only *Place* and *Discrimination.* Nor is it probable, that those, who had defined Vacuity by *Incorporiety*, should lapse into so manifest a Contradiction, as to allow it to be any Cause of Corporiety, or to constitute one moiety of Bodies. Besides, neither can *Epicurus* in any of those Fragments of his, redeemed from the jaws of oblivion by *Laertius*, *Cicero*, *Empiricus*, *Plutarch*, *&c.* nor his faithful Disciple and Paraphrast, *Lucretius*, in all his Physiology, be found, to have affirmed the Contexture of any Concretion from Inanity, but of all things simply and solely from Atoms. And for *Democritus*, him doth even *Aristotle* himself wholly acquit of this Error; for (*in* 1.*Phys.*) enumerating the several opinions of the Ancients concerning the Principles, or Elements of all things, He saith of him; *Fecit principiorum Genus unicum, Figuras verò differentes.* All therefore that lyeth against them in this case, is only that they asserted the intersperſion or dissemination of Inanity among the incontingent particles of Bodies concrete, as of absolute necessity to their peculiar Contemperation: which we conceive our selves obliged to embrace and defend, untill it shall be proved unto us, by more then paralogistical arguments, that there is any one Concretion in the world so perfectly solid, as to contain nothing of the Inane Space intermixt; which till it can be demonstrated that a Concretion may be so solid, as to be Indissoluble, we have no cause to expect.

Art. 3. Atoms not inconsistent with, because the Principles of the four vulgar Elements.

Secondly, That the Patrons of Atoms do not (as the malice of some, and incogitancy of others hath prætended, to cast disparagement upon their Theory) deny the Existence of those four Elements admitted by most Philosophers: but allow them to be *Elementa Secundaria*, Elements Elementated, *i.e.* consisting of Atoms, as their First and Highest Principles. Thus much we may certifie from that of *Lucretius* (2. *lib.*) treating of Atoms;

Unde mare, & Terra possent augescere, & unde
Adpareret spatium Cœli * *domus, altaq; tecta,*
Tolleret à terris procul, & consurgeret Aer, &c.

* *Accipitur pro Igne, seu Æthere, quem dictum* Anaxagoras *censuit*, ἀπὸ τ̃ αἴθεσθ, *ab urendo.*

Nor can the most subtle of their Adversaries make this their Tenet bear an action of trespass against right Reason; especially when their Advocate shall urge, the great Dissent of the Ancients concerning both the Number and Original of Elements, the insufficiency of any one Element to the Production of Compound Natures, and that the four vulgar Elements cannot justly be honoured with the Attributes of the First Matter.

(1) *The*

(1) *The Dissent of the Ancients about the number of Elements* cannot be unknown to any, who hath revolved their monuments and taken a list of their several opinions; their own, or their Scholiasts volumes lying open to record, that of those who fixt upon the four Vulgar Elements, *Fire*, *Aer*, *Earth*, *Water*, for the universal Principles, some constituted only *one* single first Principle, from which by Consideration and Rarefaction, the other three did proceed, and from them all Elementated Concretions: among which are *Heraclitus*, who selected Fire; *Anaximenes*, who pitched upon Aer; *Thales Milesius*, who præferred Water; and *Pherecydes*, who was for Earth. Others supposed only *Two* primary, from which likewise, by Condensation and Rarefaction the other two secondary were produced: as *Xenophanes* would have Earth and Water; *Parmenides* contended for Fire and Earth; *Oenopides Chius* for Fire and Aer; and *Hippo Rheginus* for Fire and Water. Others advanced one step higher, and there acquiesced in *Three*; as *Onomacritus* and his Proselytes affirmed Fire, Water, and Earth. And some made out the *Quaternian*, and superadded also Aer; the Principal of which was *Empedocles*. Now, to him who remembers, that there can be but one Truth; and thereupon justly inferrs, that of many disagreeing opinions concerning one and the same subject, either all, or all except one must be false; and that it is not easie which to prefer, when they are all made equally plausible by a parity of specious Arguments: it cannot appear either a defect of judgment, or an affectation of singularity in *Democritus* and *Epicurus* to have suspected them all of incertitude, and founded their Physiology on an Hypothesis of one single Principle, Atoms, from the various transposition, configuration, motion, and quiescence of whose insensible Particles, all the four generally admitted Elements may be derived, and into which they may, at the term of Exsolubility, revert without the least hazard of Absurdity or Impossibility; as will fall to our ample enunciation in our subsequent Enquiries into the Originals of Qualities, and the Causes of Generation and Corruption.

Art. 4. The dissent of the Ancients, about the number of Elements.

(2) *That one of the four Elements cannot singly suffice to the production of any Compound Nature*; needs no other eviction but that Argument of *Hippocrates* (*de Natur. Hominis*) *Quo pacto, cùm unum existat, generabit aliquid, nisi cùm aliquo misceatur?* Instance we in *Heraclitus* Proto-Element, Fire; from which nothing but Fire can be educed: though it run through all the degrees of those fertile Modifications of Densescence and Rarescence. (2) To suppose Rarefaction and Condensation, without the more or less of Inanity intercepted; as they do: is to usurp the concession of an Impossibility. (3) Tis absurd, to conceive Fire transformable, by Extinction, into any other Element: because a simple substance cannot be subject to essential transmutation. So that, if after its extinction any thing of Fire remain, as must till Adnihilation be admitted; its surviving part must be the Common Matter, such as Atoms, which according to the various and respective addition, detraction, transposition, agitation, or quiet of them, now put on the form of Fire, then of Aer, anon of Water, and lastly of Earth; since, in their original simplicity, they have no actual, but a potential Determination to the forms of all, indiscriminately. And, what is here urged, to evince the impossibility of Fires being the sole Catholique Element, carrieth the same proportion of reason and evidence, (the two pathognomick characters of Verity) to subvert the supposition of any of the other three for the substantial Principle of the rest.

Art. 5. No one of the four Elements sufficient to the production of either any of the other three, or of any Compound nature.

(3) *That*

Art. 6. The four Elements, not the Protoprinciple of Concretions.

(3) *That though the four vulgar Elements may be the Father, yet can they not be the Grandfather Principle to all Concretions*; is evidencible from hence. (1) They are Contrary each to other, and so not only Asymbolical or Disharmonious, but perfectly Destructive among themselves, at least uncapable of that mutual correspondence requisite to peaceful and durable Coalescence. (2) They are præsumed to coalesce, and their Concretions to consist without Inanity intersperſed among their incontiguous particles: which is impossible. (3) Their Defendants themselves concede a degree of Dissolution beyond them: and consequently that they know a Principle Senior. (4) Their Patrons must grant either that they, by a prævious deperdition of their own nature, are changed into Concretions, which by mutation of Forms escheat again into Elements; in which case Elements can be no more the Principle of Concretions, then Concretions the Principle of Elements, since their Generations must be vicissitudinary and Circular, as that of Water and Ice: or, that, conserving their own natures immutable, they make only confused Heaps, and confer only their visible Bulks to all productions; in which case, nothing can *revera* be said to be generated, since all Generations owe their proprieties and peculiar denominations to their Forms. (5) Whoso admits a reciprocal or symbolical Transmutation of Elements: must also admit one Common, and so a Former Matter, which may successively invest it self in their several Forms; For Contraries, while Contraries, cannot unite in the assumption of the same nature. (6) That *Achilles*, or Champian Objection, that Vegetables and Animals owe their Nutrition and Increment to the four Elements, is soon conquered by replying; that Elements are not therefore the First Principles, but rather those from whose respective Contexture they borrowed the nature of Elements, and so derived an aptitude, or qualification requisite to the condition of Aliment.

Art. 7. Atoms discriminated from the *Homoiomerical* Principles of *Anaxagoras.*

Thirdly, that the Principles of *Democritus*, *Epicurus*, &c. are *toto cœlo*, by irreconcileable disparities, different from those of *Anaxagoras*, called ὁμοιομερῆ, CONSIMILAR Parts, or abstractly, ὁμοιομέρεια, SIMILARITY (ἀπὸ τοῦ ὅμοια τὰ μέρη εἶναι τοῖς γιγνομένοις) because they are supposed to be parts in all points consimilar to the Things generated of them, according to the paraphrase of *Plutarch* (1.*placit*.3.) who there explains it by the Example of Aliment. Wherein, whether it be Wine, Water, Bread, Flesh, Fruits, &c. notwithstanding the seeming difference in the outward form, there are actually contained some Sanguineous, some Carnous, other Osseous, other Spermatick Parts, which, upon their sequestration, and selection by the Nutritive Faculty are discretely apposed to the sanguineous, carnous, osseous, and spermatick parts præexistent in the body nourisht. And the *Disparity* doth chiefly consist herein; that *They* endow their Atoms with only three congenial Qualities, *viz.* *Magnitude*, *Figure*, and *Gravity*: but *He* investeth his *Similarities* with as great variety of essential Proprieties, as there is of Qualities, nay Idiosyncrasies in Bodies.

Which to suppose, is to dote: (1) Because if the nature of the whole be one and the same with that of its Parts: then must the Principles, no less then the Concretions consisting of them, be obnoxious to Corruption. (2) Because, if it be assumed, that Like are made of Like, or that Concretions are absolutely Identical to their Elements; it cannot be denyed; that there are Laughing and Weeping Principles concurrent to the generations of

of Laughing and Weeping Compositions. (3) Because from hence, that (concordant to *Anaxagoras*) all things are actually existent in all things, and that the difference resteth only in the external Apparence, arising from the prædominion of such or such over such or such parts of the Consimilar Principles: it necessarily ensues (as *Aristotle* argueth against Him, 1 *Physic.* 4.) that in the contusion, section, or detrition of Fruits, Herbs, &c. there must frequently appear Blood, Milk, Sperm, &c. as being thereby enfranchised from the tyranny of those parts, which ruled the rost in the induction of the outward apparence, and emergent out of those Clouds which concealed and disguised them. All which are Absurdities so palpable that a blind man may thereby Distinguish the rough and spurious Hypothesis of *Anaxagoras*, from the smooth and genuine Principle of *Democritus* and his *Sectators*.

Art. 8. The principal *Difficulties* urged against the Hypothesis of Atoms, singularly solved.

Fourthly and lastly, that the *Difficulties*, which many Dissenters, and more eminently their most potent and declared Opponent, *Lactantius* (*in lib. de Ira Dei, cap.* 10.) have posted up against the supposition of Atoms for the Catholick Principle of Bodies Concrete, thereby to prævent their further approbation, and admission into the Schools; carry not moments enough of reason to inflect and determine the judgment of an æquitable Arbiter to a suspition, much less a positive negation of its verisimility. Of this we desire our Reader to be judge, when he hath made himself competent, by a patient hearing, and upright perpension of the pleas of both parties, here præsented.

(1) *Anti-Atomist*; Whence had these minute and indivisible Bodies, called Atoms, their original? or, out of what were they educed?

Atomist; This inapposite Demand lyeth open to a double response. As a mere *Philosopher* I return; that the assumption of Atoms for the *First Matter* doth expressly prævent the pertinency of this Quære. Nor would *Aristotle, Plato,* or any other of the *Ethnick* Philosophers, who would not hear of a *Creation*, or production of the First Matter out of Nothing, but contumaciously maintained its *Ingeneration* and *Eternity*, have had Gravity enough to suppress the insurrection of their spleen against the absurdity thereof: since to enquire the Matter of the *First* Matter, is a *Contradiction in terminis*. As a proficient in the sacred School of *Moses*, I may answer; that the fruitful *Fiat* of God, out of the *Tohu*, or infinite space of Nothing, called up a sufficient stock of the First Matter, for the fabrication of the World in that most excellent Form, which He had Idea'd in his own omniscient intellect from Eternity.

(2) *Anti-Atomist*: If Atoms be smooth and sphærical, as their Inventors suppose; it is impossible they should take mutual hold each of other, so as by reciprocal adhæsion and coalition to constitute any Concretion. For, what power can mould an heap of Millet-seed into a durable figure, when the Lævitude or politeness, and roundness of the Grains inexcusably interdict their Coition into a Mass?

Atomist; This Objection discovers the rancour, no less then the præcedent Interrogation did the weakness of the proposers. For, they could not be ignorant, that the Defendants of Atoms do not suppose them to be all

smooth

ſmooth and globular, but of *all ſorts of figures* requiſite to mutual *Application, Coalition, Cohærence.* And therefore they could not but expect this ſolution. That, though polite and orbicular Atoms, cannot by mutual apprehenſion and revinction each of other, compact themſelves into a Maſs; yet may they be apprehended and retained by the Hooks, and accommodated to the Creeks and Angles of other Atoms, of Hamous and Angular figures, and ſo conſpire to the Coagmentation of a Maſs, that needs no other Cæment beſides the mutual dependence of its component particles, to maintain its Tenacity and Compingence. This may receive light, from obſervation of the ſucceſſive ſeparation of the diſſimilar Parts of Bodies, by Evaporation. For, firſt thoſe Atoms, which are more ſmooth, or leſs angular and hamous, eaſily extricate themſelves, and diſperſe from the Concreted Maſs; and then, after many and various Evolutions, circumgyrations, and change of poſitions, the more rough, hamous, and angular, they expede themſelves from reciprocal concatenation, and at laſt, being wholly disbanded, purſue the inclination of their inhærent Motive Faculty, and diſappear. Experience demonſtrating, that by how much more Unctuous and Tenacious any Conſiſtence is, by ſo much a longer time do the particles thereof require to their Exhalation. Thus is Water much ſooner evaporated, then Oyl: and Lead then Silver.

(3) *Anti-Atomiſt*; If Atoms be unequal in their ſuperfice, and have angular and hamous proceſſes; then are they capable of having their rugoſities planed by detrition, and their hooks and points taken off by amputation: contrary to their principle propriety, Indiviſibility.

Atomiſt; the hooks, angles, aſperities, and proceſſes of Atoms are as inſecable and infrangible as the reſidue of their bodies, in reſpect an equal ſolidity belongs to them, by reaſon of their defect of Inanity interſperſed, the intermixture of Inanity being the Cauſe of all Diviſibility.

Hæc, quæ ſunt rerum primordia, nulla poteſt vis
Stringere, nam ſolido vincunt ea corpore demum.

(4) *Anti-Atomiſt*; That Bodies of ſmall circumſcription, ſuch as grains of ſand, may be amaſſed from a ſyndrome, and coagmentation of Atoms; ſeems, indeed, to ſtand in ſome proportion to probability: but to conceive a poſſibility, that ſo vaſt a Bulk, as the adſpectable World bears may ariſe out of things but one degree above nothing, ſuch inſenſible materials convened and conglobated; is a ſymptome of ſuch madneſs, as Melancholy aduſt cannot excuſe, and for which Phyſitians are yet to ſtudy a cure.

Atomiſt; To doubt the poſſibility, nay diſpute the probability of it: is certainly the greater madneſs. For, ſince a ſmall ſtone may be made up of a Coagmentation of grains of Sand; a multitude of ſmall ſtones, by coacervation, make up a Rock; many Rocks by aggregation, make a Mountain; many Mountains, by coaptation, make up the Globe of Earth; ſince the Sun, the Heavens, nay the World may ariſe from the conjunction of parts of dimenſions equal to the Terreſtrial Globe: what impoſſibility doth he incurr, who conceives the Univerſe to be amaſſed out of Atoms? Doubtleſs, no Bulk can be imagined of ſuch immenſe Dimenſions, as that the greateſt

greatest parts thereof may not be divided into less, and those again be subdivided into less; so that, by a successive degradation down the scale of Magnitude, we may not at last arrive at the foot thereof, which cannot be conceived other then Atoms. Should it appear unconceivable to any that a Pismire may perform a perambulation round the terrestrial Globe; we advise him to institute this Climax of Dimensions, and consider, first that the ambite of the Earth is defined by miles, that miles are commensurated by paces, paces consist of feet, feet of digits, digits of grains, &c. and then He may soon be convinced, that the step of a Pismire holds no great disproportion to a grain, and that a grain holds a manifest proportion to a digit, a digit to a foot, a foot to a pace, a pace to a perch, a perch to a furlong, a furlong to a mile, and so to the circumference of the whole Earth, yea by multiplication to the convexity of the whole World. If any expect a further illustration of this point, it can cost him no more but the pains of reading the 45. page of our Treatise against *Atheism*; and of *Archimeds* book *de Arenarum Numero.*

(5) *Anti-Atomist*; If all peices of Nature derived their origine from Individual Particles; then would there be no need of *Seminalities* to specifie each production, but every thing would arise indiscriminately from Atoms, accidentally concurring and cohæring: so that Vegetables might spring up, without the præactivity of seeds, without the assistance of moysture, without the fructifying influence of the Sun, without the nutrication of the Earth; and all Animals be generated spontaneously, or without the prolification of distinct sexes.

Atomist; This inference is ingenuine, because unnecessary, since all Atoms are not Consimilar, or of one sort, nor have they an equal aptitude to the Conformation of all Bodies. Hence comes it, that of them are first composed certain Moleculæ, small masses, of various figures, which are the seminaries of various productions; and then, from those determinate seminaries do all specifical Generations receive their contexture and Constitution, so præcisely, that they cannot owe their Configuration to any others. And, therefore, since the Earth, impregnated with Fertility, by the sacred Magick of the Creators Benediction, contains the seeds of all Vegetables; they cannot arise but from the Earth, nor subsist or augment without roots, by the mediation of which, other small consimilar Masses of Atoms are continually allected for their nutrition; nor without moysture, by the benefit of which, those minute masses are diluted, and so adapted for transportation and final assimilation; nor without the influence of the Sun, by vertue whereof their vegetative Faculty is conserved, cherished and promoted in its operations. Which Reason is æquivalent also to the Generation, Nutrition and Increment of *Animals.*

(6) *Anti-Atomist*; If your Proto-Element, Atoms, be the Principle of our 4 common Elements, according to the various Configurations of it into Moleculæ, or small masses; and that those are the Semina-

ries of all things: then may it be thence inferred, that the *Seeds* of *Fire* are invisibly contained in Flints, nay more, in a Sphærical Glass of Water, exposed to the directly incident rayes of the Sun; our sense convincing, that Fire is usually kindled either way.

Atomist; Allowing the legality of your Illation, we affirm, that in a Flint are concealed not only the Atoms, but *Moleculæ*, or Seeds of Fire, which wanting only retection, or liberty of Exsilition, to their apparence in the forme of fire, acquire it by excussion, and pursuing their own rapid motion *undiquaque*, discover themselves both by affecting the sight and accension of any easily combustible matter, on which they shall pitch, and into whose pores they shall with exceeding Celerity penetrate. Nor can any man solve this eminent Phænomenon so well, as by conceiving, that the body of a Flint, being composed of many igneous (i.e. most *exile*, *sphærical*, and *agile*) Atoms, wedged in among others of different dimensions and figures; (which contexture is the Cause of its Hardness, Rigidity and Friability) upon percussion by some other body conveniently hard, the insensible Particles thereof suffering extraordinary stress and violence, in regard it hath but little and few Vacuola, or empty spaces intermixt, and so wanting room to recede and disperse, are conglomorated and agitated among themselves with such impetuositie, as determinately causeth the constitution of Fire. It being manifest, that violent motion generateth Heat: and confessed even by *Aristotle* (1. *Meteor.* 3.) that Fire is nothing but the *Hyperbole* or last degree of Heat. Secondly, That the seeds of Fire are not contained either in the sphærical Glass or the the Water included therein; but in the Beams of the Sun (whose Composition is altogether of Igneous Atoms) which being deradiated in dispersed lines, want only Concurse and Coition to their investment in the visible form of Fire; and that the Figure of the Glass naturally induceth, it being the nature of either a Convex, or Concave Glass to transmit many Beams variously incident towards one and the same point, which the virtue of Union advanceth to the force of Ignition.

Art. 9. A recapitulation of the præmises, introductory to the verification of the præsent *thesis*.

Having thus vindicated our Atoms from the supposed Competition of the Inane Space, in the dignity of being one Principle of Bodies; reconciled them to the 4 Peripatetick Elements; discriminated them from the Consimilar Particles of *Anaxagoras*; solved the most considerable of the Difficulties charged upon them; and thereby fully performed our assumption of removing the principal prætexts of *Præjudice*: we may now, with more both of perspicuity, and hopes of perswasion, advance to the Demonstration of our *Thesis*, the Title and Argument of this Chapter.

SECT. II.

BEsides the manifest Allusion of Reason, we have the assent of all Philosophers, who have declared their opinions concerning the Composition of a Continuum, to assure a necessity, that it must consist either (1) *of Mathematical Points*; or (2) *of Parts and Mathematical points, united*; or (3) *of a simple Entity, before actual division, indistinct*; or (4) *of Individuals, i. e.* Atoms.

Art. 1. The 4 notable opinions, concerning the Composition of a *Continuum*

(1) *Not of Mathematical Points*; because Σημεῖον, *Punctum*, in the sense of *Euclid*, is *Cujus nulla sit pars*, in respect it wants all Dimensions, and consequently all Figure: which is the ground of *Aristotles* Axiom, *Punctum puncto additum non potest facere majus.* To render the absurdity of this opinion yet more conspicuous, let us remember, that the Authors and Defendants of it have divided themselves into three distinct *Factions.* (1) Some have admitted in a Continuum, points Finite *simpliciter & determinatè*; (2) Others allow points also Finite, but not *simplicitèr, sed* κατὰ τὶ *secundum quid*; (3) And others contend for points *Infinite, simplicitèr, & absolutè.* The *First and Second* endeavour to stagger the former Axiom of *Aristotle*, by an illegal transition from Quantity Continued, to *Discrete*, alledging this instance, that one Unity added to another makes a greater quantity. The *Last* recur to *Plato's* Authority, who concedeth two Infinites, a Greater and Less, commemorated by *Aristotle* (3. *phys.* 27.) Now, for a joint redargution of all, we demand, how they can divide a Line consisting of 5 insectiles into two equal segments? For, either they must cast off the intermediate insectile, or annex it to one division: if the first, they split themselves upon that rock, our *supposition*; if the last, they clash with the 9. *proposit.* 1. *lib. Euclid.* To evade the force of this Dilemma, they have invented many subterfuges: but how unsuccessfully, may be enquired of *Aristotle* (*in 6. physicor.*) who there convicts them all of either Falsity, or Impossibility; where, having præmised an excellent enunciation of the Analogy between Motion, Time, and Place, He apodictically concludes, that, if a Continuum did consist of points Mathematical, all Motions would be equally swift. Notwithstanding this, such was the contumacy of *Arriaga*, that in hopes to elude this insoluble Difficulty, He prætends to discover a new kind of Motion, distinguished by certain *Respites*, or *Pauses* intercedent; thereupon inferring that all things are moved, during their motion, with equal Celerity, but because the motion of one thing is intercepted with many pauses, and the motion of another with few, therefore doth the motion of this seem swift, and the motion of that slow; as if the degrees of *Celerity* and *Tardity* did respond to the *Frequency* and *Rarity* of *Respites* interceding. If this be true, then must a Pismire move slower then an Eagle only because this distinguisheth its motion by shorter pauses, and that by longer: nor can a Faulcon overtake a Partridge, since our eyes assure, that a Partridge strikes six strooks at least with his wings, while its pursuer strikes one. *Marcgravius* (*in histor. Animal.*

Art. 2. A Physical Continuum cannot consist of Points Mathematical.

Brasiliens) tells of an Animal, which from the wonderful tardigradous incession of it, is named by the Portugals *PRIGUIZA*, or *Lubart*: because though goaded on,, it cannot snail over a stage of 10 paces in 48 hours. Had *Arriaga* beheld this *sloth*, either He must have disavowed his nicety, or held it an equal lay which should have sooner run over a four mile course, that, or the fleetest Courser in the Hippodrome at Alexandria: because the Pauses, which intercept the constant progression of the one, in the space of 10 paces, cannot be more then those that interrupt the continuity of the others motion, in the space of four miles. These considerations therefore enable us to conclude, that those who constitute a Continuum of points Mathematical, absurdly maintain, (1) That a point added to a point makes an augmentation of quantity; (2) That no Motion is successive, but only Discrete; (3) That all motions are of equal velocity, *sunt enim puncta minimum quod pertransiri possint*: and *Arriaga's* Quiet, imagined to be in motions, is no part of Motion. (4) That a Wheel is dissolved, when circumrotated upon its Axis; for, since the Exterior Circle must præcede the Interior, at least, by one point, it follows that the same points do not correspond to the same points; which is absurd and incredible. Therefore is not a Continuum composed of Mathematical points.

Art. 3. Nor of Parts and Points Mathematical, united.

(2) *Not of Parts and Mathematical points, united.* Because (1) Parts cannot be conceived to be united or terminated, unless by an adæquation of Points to them; (2) Since those points, which are imagined to concur to the conjunction of parts, are even by *Suarez* the chief Patron of them, (*in Metaphys. Disput. de quantitat.*) named *Entia Modalia*; it must thence follow, that Parts, which are *Entia Absoluta*, cannot consist without them; which is ridiculous. (3) Since they allow no Last Part, how can there be a Last, *i.e.* a Terminative Point? (4) Either something, or nothing is intermediate between one Indivisible and other Indivisibles: if something; then will there be a part without points; if nothing, then must the whole consist of Indivisibles, which is the point at which we aim.

Art. 4. Nor of a simple Entity, before division indistinct: but of Indivisibles

(3) *Not of a simple Entity before Division, Indistinct*; as not a few of our Modern Metaphysicians have dreamt, among whom *Albertinus* was a Grand Master. Who, that He might palliate the Difficulty of the Distinction of Parts, that threatned an easie subversion of his phantastick position; would needs have that all Distinction doth depend *ab Extrinseco*, i.e. ariseth only from *mental Designation*, or actual Division. But, O the Vanity of affected subtilty! all that He, or his whole faction hath erected upon this foundation of Sand, may be blown down with one blast of this single Argument. Those things which can exist being actually separate; are really distinct: but Parts can exist being actually separate; therefore are they really distinct, even before division. For Division doth not give them their peculiar Entity and Individuation, which is essential to them and the root of Distinction. The *Major* is the general and only Rule of Distinctions, which whoso denyes cannot distinguish *Plato* from *Aristotle*, nor *Albertinus* from *Thersites*. The *Minor* holds its verity of sense, for the part A, is existent without the part B, though being before conjoyned, they both conspired to the constitution of one Continuum. And that the Propriety of Entity, is the Base of Distinguibility, is verified by that serene Axiome, *Per idem res distinguitur ab omni alia, per quod constituitur in suo esse*. Therefore cannot a Continuum consist of a simple Entity before division indistinct:

indistinct: but of *Individuals*, or *Atoms*, which is our scope and Conclusion.

Our *second* Argument flowes from the nature of *Union*. For the decent introduction of which, we are to recognize, that a *Modal Ens* cannot subsist without conjunction to an *Absolute*; as, to exemplifie, *Intellection* cannot be without the *Intellect*, though on the reverse, the Intellect may be without the act of Intellection: so likewise cannot *Union* be conceived without *Parts*, though on the contrary, Parts may be without Union. And hence we thus argue:

Art. 5. A second Apodictical reason, deduced from the nature of Union, evincing that Atoms are the First and Catholick Principle of Concretions.

That only which is made *independentèr à subjecto*, or holds its essence *ex proprio*, is the Term of Creation; but Union is not independent *à subjecto*: therefore is not Union the Term of Creation. Since therefore the Term of Creation in the First Matter is devoid of Union; it must consist of Individuals, for Division proceeds from the solution of Union. This derives Confirmation from hence; that the subject from whence another is deduced, must be præcedent in nature to that which is derived: now the Parts of the First Matter are the Subject from whence Union is derived; *Ergo*, are the Parts of the First Matter in nature præcedent to all Union; and consequently they are Individuals, i.e. *Atoms*.

Art. 6. An objection prævented.

If it be objected, that the understanding cannot apprehend the First Matter to consist without some implicite Union we appeal to that Canon, *Quod non est de essentia rei, non ingreditur ejus conceptum:* For, Union not being of the essence of the parts of the First Matter, ought not to fall under the comprisal of that Idea, by which we speculate them. And, upon consequence, if they are conceived without implicite Union: certainly they are conceived as *Individuals*, or Atoms. The *Major* is justified by that common Principle; *Ex eo quod res est, vel non est, dici potest vel esse, vel non esse; conceptus enim mensura est rei Entitas, mensura autem vocis est conceptus.* And the Certitude of the *Minor* results from that Metaphysical Canon, *Nullus modus actualis est de Essentia rei.*

Art. 7. The reason of the Authors supercession of all other Arguments of the like importance.

Upon these *Two* Arguments might we have accumulated sundry others of the like importance, such as are chiefly insisted upon by the Modern Redeemers of *Democritus* and his noble *Principles* from that obscurity and contempt, which the Envy of Time and the Peripatetick had introduced, *Sennertus* (*in Hyponemat. de Atomis.*) and *Magnenus* (*in cap. 2. disput. 2. de Atomis.*) and, in imitation of their ample model, have explicated the mystery of our Thesis, from the *Syncritical* and *Diacritical* Experiments of Chymistry, (whereby all Bodies are sensibly dissolved into those *Moleculæ*, or First Conventions of Atoms, which carry their specifical seminaries; and the Heterogeneous parts of diverse Concretions, after dissolution, coagmentated into one mass, and united *per minimas*) but most eminently from that natural miracle, the *Tree of Hermes*, made by an artificial Resuscitation of an entire Herb from the Atoms of it in a Glass, honestly effected by a Polonian Physitian in the præsence of *Gaffarel*, as himself records (*in Curiositat. inaudit.*) asserted by *Quercetan* (*in defens. contra Anonym. cap. 23*) and to the life described by *Hierem. Cornarius*, famous for his long profession of Philosophy and Medicine at *Brandenburgh*, in an Epistle to the great *Libavius*, which he therefore made an Appendix to his acute dissertation

de

de Resuscitatione Formarum ex cineribus plantarum (*syntagm. Arcan. Chymic. lib.* 1. *cap.* 22.) But having upon an upright and mature perpension of their weight, found it such, as warrants our adscription of them to the golden number of those Reasons, that are λόγοι ἀναπαστικοὶ, καὶ οὐκ εὔποροι διαλύειν (as *Aristotle* speaks of other Arguments concerning the same subject, *in de Generat. & Corrupt. cap.* 2.) such as urge and compel the mind to an assent, and bid defiance to all solution: we judged our præsent Fundamental sufficiently firm, though erected upon no other but those two pillars; especially when we remembred that *supererogation* is a kind of *Deficiency*.

CHAP.

CHAP. IV.

The Essential Proprieties of Atoms.

SECT. I.

THat our Theory of those *Qualities*, which being congenial to, and inseparable from Atoms, fulfil the necessary *Attributes* of the First Universal Matter, may, according to the Method requisite to perspicuity, immediately succeed to our Demonstration of their Existence, and the impossible Elementation of Concrete substances from any other general Principles; and that the expectance raised in our Reader by our frequent transitory mention of the *Proprieties* of Atoms, may be opportunely sated by a profess Enumeration and Enunciation thereof: are the two reasons that justifie our subnection of this to our præcedent Discourse.

Art. 1. The two links connecting this to the præcedent Chapter.

The PROPRIETIES of our Atoms difference themselves into *General* and *Specifical*. The General are (1) *Consimilarity of Substance*; for all Atoms being equally Corporeal and solid, must be substantially identical, or of one and the same nature, knowing no disparity of Essence. Thus much *Aristotle* intimates (1. *Physic.* 2.) when He infers *Democritus* holding, *esse principiorum* τὸ γένος ἕν, *Genus unicum*, or τὴν φύσιν μίαν, *Naturam unam*, that the Principles of all things are of one Kind, or of one Nature. In respect of this, there is no difference among Atoms. (2) *Magnitude*, or Quantity, which they cannot want, since they are not Mathematical Insectiles, but Material Realities, and Quantity or Extension is the proper and inseparable affection of Matter; and therefore every thing hath so much of Extension, as it hath of Matter. (3) *Figure*, which is the essential Adjunct of their Quantity. For, insomuch as Atoms are most minute Bodies, and stand diametrally opposed to Points Imaginary; therefore must they have dimensions real, and consequently a termination of those dimensions in their extreme or superfice, i. e. determinate Figure. Which is the ground of *Magnenus* 3. *Postulate* (*de Atomis*, *disput.* 2.) *Quicquid magnitudinem*

Art. 2. The *General* Proprieties of Atoms: and the *Inseparability* of each, demonstrated.

magnitudinem habet, finitamque extensionem, si pluribus dimensionibus substet, concedatur illi suam inesse Figuram; and perhaps also of *Euclids* definition of Figure, *Figura est, quæ sub aliquo, vel sub aliquibus terminis comprehenditur.* Nor have they only a Plain figure, but a *solid* one, according to that of *Euclid* (*lib.* 2. *def.* 1.) *solidum est, quod longitudinem, latitudinem, & crassitudinem habet.* (4) *Gravity*, or Weight; which is also coessential to them in respect to their solidity, and the principle of their Motion. And therefore *Epicurus* had very good cause to add his τὸ βάρος, to *Democritus* μεγέθος τε καὶ σχῆμα: which *Plutarch* (1.*placit.* 3.) expresly renders thus; ἀνάγκη γὰρ κινεῖσθαι τὰ σώματα τῇ τοῦ βάρους πληγῇ, *quia necesse est Corpora moveri ipso impetu Gravitatis.* For, having supposed that *Motion* was essentially competent to Atoms, it must have been no venial defect, not to have assigned them a certain special *Faculty*, or Virtue for a *Cause* to that motion præsumed; and such must be their inhærent Gravity, or the tendency of weight. Now, in respect to either of these three last Proprieties, Atoms may be conceived to admit of difference among themselves; for, in regard of Magnitude, some may be greater then others, of Figure, some may be sphærical, others cubical, some smooth, others rough, &c. and of Gravity, some may be more, and others less ponderous, though this can cause no degrees of Velocity or Tardity in their Motion, it being formerly demonstrated, that two bodies of different weights are æqually swift in their descent.

Art. 3. The *Resistence* of Atoms, no distinct propriety; but pertinent to their Solidity or Gravity.

To these 4 Essential Attributes of Atoms, *Empiricus* hath superadded a Fifth, *viz.* Ἀντιτυπία, *Renitency*, or Resistence. But, by his good leave, we cannot understand this to be any distinct Propriety; but as τὶ ὑποκείμενον, something resilient from and dependent on their *solidity*, which is the formal reason of Resistence: besides, we may confound their Renitency with their Gravity, insomuch as we commonly measure the Gravity of any thing, by the renitency of it to our arms in the act of Elevation. Which may be the reason, why *Aphrodisæus* (*lib.* 1. *Quest. cap.* 2.) enumerating the proprieties of Atoms, takes no notice at all of their Gravity; but blends it under the most sensible effect thereof, *Resistence.*

Art. 4. The *specifical* Proprieties of Atoms.

The *specifical* are such as belong to Atoms of particular sorts of Figure, as *Smoothness*, *Acuteness*, *Angularity*, and their Contraries, *Asperity*, *Obtuseness*, *Orbicularity*, &c. These, in the dialect of *Epicurus*, are συμφυῆ, *Cognatæ Proprietates.* Now all these Proprieties, both Generical, and Specifical, or Originary and Dependent, are truly ἀχώριστα, as *Plutarch* (1.*adv. Colot.*) calls them, *Congenial*, and *inseparable.* Other Proprieties there are adscriptive to Atoms, such as their *Concurse*, *Connexion*, *Position*, *Order*, *Number*, &c. from which the Qualities of Compound Bodies do emerge; but since they are only *Communia Accidentia*, Common Accidents, or (as *Lucretius*) *Atomorum Eventa*, the fortuitous Events of Atoms considered as complex and coadunated in the Generation of Concretions, and not in the intire simplicity of their Essence; and consequently *seperable* from them: therefore may we hope, that our Reader will content himself with our bare mention of them in this place, which is designed for the more advantagious Consideration of only the *Essential* and *Inseparable.*

SECT. II.

Concerning the Magnitude of Atoms.

Art. 1. By the *Magnitude*, is meant the *Parvity* of Atoms.

MAgnitude and Atoms, though two terms that make a graceful Consonance to ears acquainted with the most charming harmony of Reason, may yet sound harsh and discordant in those of the Vulgar, which is accustomed to accept Magnitude only *Comparatively*, or as it stands Antithetical to *Parvity*: and therefore it concerns us to provide against misapprehension by an early advertisement; that in our assumption of Magnitude as the first essential Propriety of Atoms, we intend not that they hold any *sensible* bulk, but that, contrary to Insectiles, or Points Mathematical, they are *Entities Quantitive simply*, i.e. Realities endowed with certain corporeal Dimensions, though most minute, and consisting in the lowest degree of physical quantity; so that even those of the largest size, or rate, are much below the perception and discernment of the acutest Opticks, and remain commensurable only by the finer digits of rational Conjecture. And somewhat the more requisite may this Præmonition seem, in respect that no meaner an Author then *Theodoret* hath, through gross inadvertency, stumbled at the same block of ambiguity. For (*in Serm.* 4. *therapeut.*) He positively affirms, that *Democritus*, *Metrodorus*, and *Epicurus*, by their exile Principles, Atoms, meant no other but those small pulverized fragments of bodies, which the beams of the Sun, transmitted through lattice Windows, or chincks, make visible in the aer: when according to their genuine sense, one of those dusty granules, nay, the smallest of all things discernable by the eyes of *Linceus*, though advantaged by the most exquisite Engyscope, doth consist of Myriads of Myriads of thousands of true Atoms, which are yet corporeal and possess a determinate extension.

Art. 2. A consideration of the *Grossenes* of our *senses*, and the extreme *subtilty* of *Nature*, in her operations; præparatory to our Conjectural apprehension of the Exiguity of Her Materials, *Atoms*.

To avert the Wonder impendent on this nice assertion, and tune our thoughts to a key high enough to attain the Verisimility thereof; We are first to let them down to a worthy acknowledgment of the exceeding *Grossnesse* and *Dulnesse* of our *Senses*, when compared to the superlative *Subtility*, and *Acutenes* of *Nature* in most of her Operations: for that once done, we shall no longer boast the perspicacity of our Opticks, nor circumscribe our Intellectuals with the narrow line of our sensible discoveries, but learn there to set on our Reason to hunt, where our sense is at a loss. Doubtless, the slender Crany of a Pismire contains more distinct Cellules, then that magnificent Fabrick, the Eschurial, doth rooms; which though imperceptible to the eye of the body, are yet obvious to that of the mind: since no man can imagine how, otherwise, the Faculties of sense and voluntary Motion can be maintained, a perpetuall supply of Animal (or, as Dr. *Harvey* will have them, Vital) spirits being indispensably necessary to the continuation of those actions; and therefore there must be Elaboratories for the præparation and confection, Treasuries for the conservation, and various Conduits for the emission, and occasional transvection of them

 into

into the Nerves and Muſcles of that induſtrious and provident Animal. The due reſentment of which prægnant Inſtance, is alone ſufficient to demonſtrate the incomputable degrees of diſtance betwixt the ſenſible Capacity of man, and the curious Mechanicks of Nature: and make the acuteſt of us all call for a Table-book to enroll this Aphoriſm; *Ubi humana induſtria ſubtilitaſque deſinit, inde incipit induſtria ſubtilitaſque Naturæ.* The wings of our Arrogance being thus clipt, let us diſplay thoſe of our Diſcourſive Faculty, and try how near we can come to deprehend the Magnitude, *i. e.* the *Parvity* of Atoms, by an ingenious Conjecture.

Art. 3. The incomprehenſible ſubtility of Nature, argued from the *Artifice* of an exquiſite *Watch*, contrived in a very narrow room.

Conſider we, firſt, that an exquiſite Artiſt will make the movement of a Watch, indicating the minute of the hour, the hour of the day, the day of the week, moneth, year, together with the age of the Moon, and time of the Seas reciprocation; and all this in ſo ſmall a compaſs, as to be decently worn in the pall of a ring: while a bungling Smith can hardly bring down the model of his groſſer wheels and balance ſo low, as freely to perform their motions in the hollow of a Tower. If ſo; well may we allow the finer fingers of that grand Exemplar to all Artificers, Nature, to diſtinguiſh a greater multiplicity of parts in one Grain of *Millet ſeed*, then ruder man can in that great Mountain, *Caucaſus*; nay, in the whole *Terreſtrial Globe.*

Art. 4. The vaſt multitude of *ſenſible particles*, & the vaſter of *Elemental Atoms*, contained in one grain of *Frankinſenſe*; exactly calculated.

Conſider we, with *Magnenus*, that one grain of Frankinſenſe being fired, doth ſo largely diffuſe it ſelf in fume, as to fill a ſpace in the aer, more then *ſeven hundred millions* of times greater then it poſſeſſed before combuſtion. For, to the utmoſt diſperſion of its fume, the ſpace might eaſily have received of grains of Frankinſenſe, equal in dimenſions to the ſeed of a Lupine,

according to its Altitude		720
according to its Latitude		900
in the	Longitude	1200
	Superfice of the whole figure	5184000
	Superfice of the end only	648000
	Area, or whole encloſure	777600000

Since, therefore, our noſtrils aſcertation, that in all that ſpace of Aer, there is no one particle which is not impræ̃gnated with the fragrant exhalations of that combuſt grain of Frankinſenſe, which, while it was entire might be by a ſteddy hand, a ſharp inciſion knife, and a good magnifying Glaſs, or by that ſhorter way of trituration, divided at leaſt into a thouſand ſenſible particles: it muſt follow, in ſpite of Contradiction, that the ſenſible odorous particles of it do fulfil the number of 777600000000. And, inſomuch as each of theſe ſenſible Particles, is mixt, it being lawful and commendable according to the ſubtile ſpeculations of *Archimed* (*in Arenar.*) to aſſume that the ſmalleſt of them is compoſed of a Million of Elemental Atoms: therefore by the ſame rule, muſt there have been in the whole Grain of Elemental Atoms 777600000000000000, at leaſt. If ſo; we have but one ſtep lower to Inſectility, and ſo may gueſs at the Exiguity of a ſingle Atome.

Conſider

Art. 5. The Dioptrical ſpeculation of a *Handworm*, diſcovering the great variety of *Organical Parts* therein, and the innumerability of their *Component Particles.*

Conſider we the delicate Contexture of Atoms, in the body of that ſmalleſt of Animals, a *Handworm.* Firſt, if we ſpeculate the *outſide* of that organical tenement of life, a good Engyſcope will præſent our eye with not only an oval-head, and therein a mouth, or prominent ſnout, armed with an appendent proboſcis, or trunk conſiſting of many villous filaments contorted into a cone, wherewith it perforates the skin, and ſucks up the bloud of our hands; but alſo many thighs, leggs, feet, toes, laterally ranged on each ſide; many hairy tufts on the tail, and many aſperities, protuberances, and rugoſities in the skin. Then our Reaſon if we contemplate the *inſide* thereof, will diſcover a great variety of Organs neceſſary to the ſeveral functions of an Animal. For *Nutrition*, there muſt be Gullet, Stomach, Inteſtines, Liver, Heart, Veins; or at leaſt parts in their offices and uſes perfectly analogous thereto: For *Vitality*, there muſt be Lungs, and Heart for the præparation and confection, and Arteries for the general diffuſion of Spirits; for *Locomotion* voluntary and *ſenſation*, there muſt be Brain, Spinal Marrow, Nerves, Tendons, Muſcles, Ligaments, Articulations; and for the ſupport and firmitude of all theſe, there muſt be ſome more ſolid *ſtamina*, or a kind of Bones and Cartilagineous contextures; in a word, there muſt be all members requiſite to entitle it to Animation, with a double skin for the inveſtiment of the whole Machine. Now, if we attentively compute, how many particles go to the compoſure of each of thoſe organical parts, and how many Myriads of Atoms go to the contexture of each of thoſe particles (for even the Spirits inſervient to the motion of one of its toes, are compoſitions conſiſting of many thouſands of Atoms), as we ſhall think it no wonder, that the exile and induſtrious fingers of Nature have diſtinguiſhed, ſequeſtred, ſelected, convened, accommodated, coadunated, and with as much aptitude as decorum diſpoſed ſuch an incomprehenſible multitude of Parts, in the ſtructure of ſo minute an Animal; ſo may we, in ſome latitude of analogy, conjecture the extreme Parvity of Her common Material, Atoms. On this ingenious pin hung the thoughts of *Pliny*, when (*in lib.* 11. *cap.* 1 *&* 2.) He exclaimed, *Nuſquam alibi Naturæ artificium ſpectabilius eſt, quàm in Inſectis: in magnis ſiquidem corporibus, aut certè majoribus, facilis officina ſequaci materia fuit. In his verò tam parvis, atque tam nullis; quæ ratio, aut quanta vis, tanquam inextricabilis perfectio? ubi tot ſenſus collocavit in Culice? & ſunt alia dictu minora. Sed ubi viſum in ea prætendit? ubi Guſtatum applicavit? ubi odoratum inſeruit? ubi truculentam illam, & proportione maximam vocem ingeneravit? Qua ſubtilitate pennas adnexuit, prælongavit pedum crura, diſpoſuit jejunam caveam, uti alvum, avidam ſanguinis, & potiſſimum humani ſitim accendit? Telum verò perfodiendo tergori, quo ſpiculavit ingenio? atque cùm præ exilitate pene non videatur, ita reciproca generavit arte, ut fodiendo acuminatum, pariter ſorbendoque fiſtuloſum eſſet, &c.*

Art. 6. A ſhort Digreſſive Deſcant upon the Text of *Pliny*, touching the multiplicity of parts in a *Flea*; hinting the poſſible perſpicacity of *Reaſon.*

Here had we haulted a while, and wondered, how *Pliny* could, without the aſſiſtance of a *Magnifying Glaſs* (an Invention, whoſe Antiquity will hardly riſe above the laſt revolution of Saturn) deprehend ſo vaſt a multiplicity of Parts in the machine of an Inſect, of ſo ſmall circumſcription, that to commenſurate the Baſe of the viſive Cone, by which its ſlender image is tranſmitted to the pupil of the eye, would trouble a good

Master in Opticks, and drive him to the *Minimus Angulus* of *Euclid*: but that it soon came into our thoughts, that He speculated the same by the subtiler Dioptrick of *Reason*; which indeed is the best Engyscope of the Mind, and renders many things perspicuous to the *Understanding*, whose exceeding Exility is their sufficient Darkness.

Art. 7. The Exility of Atoms, conjectural from the great diffusion of one Grain of *Vermillion* dissolved in Water.

To put more weights into the Scale of Conjecture, let us moreover observe; how great a quantity of Water may be tinged with one grain of Vermillion; how many sheets of Paper may be crimsoned with that tincture; how innumerable are the points, by the apex of a needle, designable on each of those sheets: and when 'tis manifest that many particles of Vermillion are found in each of those points; who can longer doubt, that the particles comprehended in the compass of that grain are indefinable by the exactest Arithmetique.

Art. 8. The same, inferrible from the smal quantity of *oil* deprædated by the *Flame* of a Lamp, in a quarter of an hour.

Again, (for we could be content, to let the Almund tree bud, before we take off our cogitations from this pleasant Argument) consider we, how small a portion of oyl is consumed by the flame of a Lamp, in a quarter of an hour; and yet there is no moment passeth, wherein the stock of flame is not wasted and as fast repaired, which if it could be conserved alive all at once, would fill not only whole rooms, but even ample Cities: and if so, what need we any further eviction of the extreme *Exiguity* of those Parts, of which all Concretions are material'd?

Art. 9. The *Microscope* of great use, in the discernment of the minute particles of Bodies: and so advantageous to our Conjecture, of the exility of Atoms.

Had the Ancients, indeed, been scrupulous in this point; their want of that useful Organ, the Engyscope, might in some part have excused their incredulity: but for us, who enjoy the advantages thereof, and may, as often as the Sun shines out, behold the most lævigated Granule of dissolved Pearl, therein præsented in the dimensions of a Cherry stone, together with its various faces, planes, asperities, and angles, (such as before inspection we did not imagine) most clear and distinct, longer to dispute the possible Parvity of Component Principles, is a gross disparagement to the Certitude of Sense, when it is exalted above deception, and all possible impediments to its sincere judicature are prævented.

Conclude we therefore, since the Diametre of a granule of Dust, when speculated through a good Engyscope, is almost Centuple to the diametre of the same, when lookt on meerly by the eye, on a sheet of Venice Paper: we may safely affirm, with *Archimed* (*in arenario.*) that it is conflated of ten hundred thousand millions of insensible Particles; which is enough to verifie our præsent Assumption.

SECT. III.

Concerning the Figures of Atoms.

IN all the sufficiently prolix Discourses of the Ancient Assertors of Atoms, concerning their FIGURE, and the no sparing Commentaries of the Moderns thereupon; whatever seems either worthy our serious animadversions, or in anywise pertinent to our Designation: may be, without perversion, or amission of importance, well comprized under one of these 3 *Canons.* (1) *That Atoms are, in their simple essence, variously figurate*; (2) *That the distinct species of their Figures are Indefinite, or Incomprehensible, though not simply, or absolutely Infinite*; (3) *That the Number of Atoms retaining unto, or comprehended under each peculiar species of Figure, is not only indefinite, but simply Infinite.*

Art. 1. An Epitome of all that directly concerns the *Figures* of Atoms in 3 General *Canons.*

Concerning the FIRST; we advertise, that no man is to conceive them to have supposed the Figure of Atoms deprehensible by the Sight, or Touch, no more then their Magnitude, the termination whereof doth essence their figure, according to that definition of *Euclid*, lately alledged; but such, as being inferrible from manifold reasons, is obvious to the perception of the Mind. Which *Plutarch* (1. *placit.* 2.) personating *Epicurus*, expressly declares in his, ἰδία ἔχειν σχήματα λόγῳ θεωρητά, *Atomos proprias habere, sed ratione, seu mente contemplabiles Figuras.* To avouch the verity hereof, we need no other argument but this; insomuch as every Atome hath some determinate Quantity, or Extension, and that all Quantity must be terminated in some certain Figure: therefore is it necessary, that however exile the dimensions of an Atome are, yet must the superfice thereof be or plane, or sphærical, or angular, or Cubical, &c. i. e. of some figure either regular, or irregular.

Art. 2. The *First* Canon, explained and certified.

Doth any incline to believe, that the extreme Exility of Atoms may necessitate their general *Roundness*; and the rather because he perceives all those dusty fragments of bodies, visible in the aer by Sunshine, (which are the Atoms of the Vulgar) to be clad in that figure: We advise him to collect a multitude of them, on a clean sheet of the finest white Paper, and then speculate any the smallest granules among them with a perfect Engyscope. For, in so doing He will acquire autoptical satisfaction, that none of them are exactly orbicular and perpolite, but all of various angular figures, pyramidal, pentahedrical, cubical, trapezian, heptahedrical, octahedrical, dodecahedrical, icosahedrical, &c. nay of so many irregular and dissimilar apparences, as must refute his error with a delightful Wonder. Though, in troth, it can be no wonder to him that considers the Defect of any Cause, that should break off the angles from those fragments volatile, after their detrition from hard bodies, and so tornate them into smooth sphærules: observation ascertaining, that when hard bodies are broken into large pieces, those pieces are alwayes angular, and extremely discrepant in the parts of their superfice; and Reason thence

Art. 3. The *Exility* of Atoms, doth not necessitate their *General Roundness*; contrary to the common conceit.

thence inferring, that lesser pieces must confess the like irregularity and disparity of figures among themselves. True it is, they enter the eye in a perfect sphear, because of the exiguity of their Angles; for every small, or remote Icosahedrical body, nay even Oblong and Cylindrical, posited at excessive distance, the extremities of their images being, in their long trajection through the aer, confracted, retused, and so entering the *Retina tumica* in a lesser angle; alwayes appear orbicular. Thus, if we speculate any star, which is not of a spherical figure, as *Saturn*, which both *Kircher* and *Hevelius*, having beheld it with their excellent Telescopes, describe in this apparence

(*in Photismo Corporum cœlestium; & Selenographia.*)

it will deradiate its species in a pyramid, which hath so many distinct faces, as are comprehended in the Section, made from the position of the eye, in right lines drawn to the circumference thereof; and yet in the decurse of the angle, they all become so retused, as that the image of the Starr is received by the eye in a figure perfectly sphærical. And, as the excessive Remotion, so likewise doth the immoderate Exiguity of objects cause our sense not to discern their genuine Figure and so to delude the common judicatory Faculty, by giving in dissimilar images: as is demonstrable from the reason, whereby *Magnifying Glasses* meliorate the sight, i. e. their enlarging the basis of the *Radius Visorius*, according to the theory of *Kircherus* (*in Magia Catoptrica.*) and *Scheinerus* (*in Fundam. Optic lib. 3. part. 2.*). Thus, if he credit the single information of his eye, who doth not judge a *Handworm* to be exactly round? and yet let him but behold it through an Engyscope, and he shall at first inspection discern the several divarications of its Members, Leggs, Feet, Tail, and other parts, no less diverse in proportion, then those observed in multipedous Insects, of farr greater bulk.

Art. 4. The *Diversity* of Figures in Atoms, evicted from the sensible *Dissimilitude* of *Individuals*, as well Animate, as Inanimate.

To guard this Assertion of the variety of Figures in Atoms, with other Arguments of its Verisimility; let us Consider, that all Individuals, as well Animate, as Inanimate, are distinguishable each from other of the same species, by some peculiar signature of disparity visible in the superficial parts of their Bodies: and Reason will thereupon whisper us in the ear, that they are also different in their Configurations; and that the Cause of that sensible Dissimilitude, must be a peculiar, or idiosyncritical Contexture of their insensible Component particles. For *Animals*, we may instance in the noblest species. Among the Myriads of swarms of men, who can find any two Persons, so absolute Twinns in the aer of their faces, the lines of their hands, the stature of their bodies, proportion of their members, &c. as that Nature hath left no impression, whereby not only their familiar friends, but even strangers comparing them together, may distinguish one from the other? For *Inanimates*; doth it not deserve our admiration, that in a whole Bushel of Corn, no two Grains can be found so exquisitely respondent in similitude, as that a curious eye shall not discover some disparity betwixt them: and yet we appeal to strict observation, for the verity thereof. If our leasure and patience will bear it, let us conferr many Leaves, collected at one time from the same Tree; and try whether among them all we can meet with any two perfectly consimilar in magnitude, colour, superfice, divarications of filaments, equality of stemms, and other external proportions. If not; we must assent to a variety of Con-

Configurations in their parts, and consequently admit no less, but indeed a farr greater variety of Figures in the particles of those parts, their Atoms.

Art. 5. A singular *Experiment*, autoptically demonstrating the various Configurations of the minute Particles of Concretions.

To these it concerns us to annex one singular *Experiment*, easie, delightful, and satisfactory. Exposing a vessel of Salt water, to the Sun, or other convenient heat, so as the aqueous parts thereof may be gently evaporated; we may observe all the Salt therein contained, to reside in the bottome, conformed into Cubical Masses. And, if we do the like with Alum Water, the Alum will concrete in Octohedrical figures. Nay, the Cubes generated of Salt, will be so much the larger, by how much the more and deeper the Water, wherein it was dissolved; and *è contra*, so much the smaller, by how much shallower the Water: so that from a large vessel will arise saline Cubes in dimensions equal to those of a Gamesters Die; but from a small we shall receive Cubes, by five parts of six, lesser, and if we drop a small quantity of brine upon a plane piece of Glass, the Cubical Concretions thereon fixing, will be so minute, as to require the help of an Engyscope to their discernment. Now, as to that part of this Experiment, which more directly points at our præsent scope; we may perceive the greater Cubes to be a meer Congeries or assembly of small ones, and those small ones to be coagmentated of others yet smaller, or certainly composed of exiguous Masses bearing the figure of Isoscele Triangles, from four of which convened and mutually accommodated, every Cube doth result. Hence is it obvious to Conjecture, that those small Cubes, discernable only by an Engyscope, are contexed of other smaller, and those again of smaller, until by a successive degradation they arrive at the exility of Atoms, at least of those Moleculæ, which are the Seminaries of Salt, and, according to evident probability, of either exactly Quadrate, or Isoscele Triangular figures. Now, insomuch as the same, allowing the difference of Figure, is conjectural also concerning Alum, Sugar, Nitre, Vitriol, &c. Saline Concretions: why may we not extend it also to all other Compositions, especially such as have their Configurations certain and determinate, according to their specifical Nature.

Art. 6. A variety of Figures in *Atoms*, necessary to the variety of all *Sensibles.*

Again, whoso substracts a diversity of Figures from Atoms: doth implicitely destroy the variety of sensibles. For, what doth cause the Odoratory Nerves of man to discriminate a Rose from Wormwood? but the different Configurations of those Moleculæ, *Flores Elementorum*, or Seminaries of Qualities, which being conflated of exceeding fine and small congregations of Atoms, do constitute the odorable species; and so make different impressions upon them. What makes a Dog, by the meer sagacity of his nose, find out his Master, in the dark, in a whole host of men? but this; that those subtle *Effluvia*, or Expirations, emitted insensibly from the body of his Master, are of a different Contexture from those of all others, and so make a different impression upon the mamillary processes, or smelling Nerves of the Dog. The like may also, with equal reason, be demanded concerning those wayes of Discrimination, whereby all Animals agnize their own from others young; and Beasts of prey, in their difficult venations, single out the embossed and chased; though blended together with numerous Herds of the same species.

Nor

Nor doth the Verisimility hereof hold only in objects of the sight and smelling; but diffuseth to those of the Hearing, Tasting, and Touching: as may be soon inferred by him, who shall do us the right, and himself the pleasure to descend to particulars. These things jointly considered, we are yet to seek, what may interdict our Conception of great Diversity of Figures in the Principles of Concretions, Atoms.

Art. 7. The *second* Canon, explained and Certified.

Concerning the SECOND, *viz.* Εἶναι τὰ σχήματα τῶν Ἀτόμων ἀπειρίλητα, οὐκ ἄπειρα, *esse Figuras Atomorum incomprehensibiles, non infinitas*, that the figures of Atoms are so various, as to be incomprehensible, though not simply infinite: this can be nor Problem, nor Paradox. For, though the species of Regular Figures be many, of Irregular more, and of those that are producible from both regular and irregular, according to all the possible wayes of their Commixture and Transposition, so amusingly various; as that the mind of man, though acquainted with all the mysteries of Arithmetique and Algebra, cannot attain to a definite compute, nor præcise description of them all: yet do they not run up to absolute Infinity, so as that there can be no extreme and terminating species. That the variety of Figures competent to Atoms, ought to be held *only Incomprehensible*; these Reasons evince (1) Since Atoms are circumscribed and limitate in Magnitude, that Configurations in diversity infinite should arise from that finite magnitude, is clearly impossible. For, every distinct figuration præsupposeth a distinct position of parts; and the parts of finite Magnitude may be transposed so many several wayes, as no further way of transposition can remain possible: otherwise there would be new and new parts inexhaustibly, and so magnitude would become infinite. (2) If the Diversity of figures were infinite, then could not the Qualities arising to concretions from the various Contexture of their parts, be certain and determinate: since, allowing an inexhaustible novelty of Configurations, their insensible particles might be so variegated, as that a better then the best, and a worse then the worst of Configurations might be produced; which is no obscure absurdity. (3) All things are determined by Contrary Qualities, which are so extreme, that they admit many mediate or Inclusive degrees, but none Exclusive, or without their boundaries. (4) That only a Finite variety is sufficient to that incomprehensible diversity of figures, observed in nature.

That the variety of Figures allowable to Atoms, is *Incomprehensible*; may be thus familiarized. Thinke we, what great multiplicity of words may be composed of only a few Letters variously transposed. For, if we assume only Two Letters, of them we can create only two words; if three, 6; if four, 24; if five, 120; if six, 720; if seven, 5040; if eight, 40320; if nine, 362880; if ten, 3628800: so that before we fulfil the 24 Letters, the number of words componible of them, according to all the possible ways of positions, will swell above our computation. This done, let us no more but exchange Letters for Figures, and assuming only Round, Oblong, Oval, Eliptick, Lenticular, Plane, Gibbous, Turbinate, Hamous, Polite, Hispid, Conical, Obtuse, Tetrahedical, Pentahedrical, Hexahedrical, Heptahedrical, Dodecahedrical, Icosahedrical, Striate or skrewed, Triangular, Cylindrical Atoms: cast up to what an inassignable number the Figures producible from them, according to the several wayes of their Composition and transposition, may amount. Doubtless, we shall discover so great variety, as to

to elude our comprehenſion. If ſo, how much more incomprehenſible muſt that Diverſity be, which is poſſible from the aſſumption, and complication of all the Regular and Irregular figures, that a good Geometrician can conceive, and which it is juſtifiable for us to allow exiſtent in Nature?

But as for the LAST; viz. *that the number of Atoms, retaining to each diſtinct ſpecies of Figures, ariſeth to Infinity*, i. e. that there are infinite Oval, infinite Pyramidal, infinite Sphærical, &c. Atoms: from this we muſt declare our Diſſent. Becauſe, how great a number ſoever be aſſigned to Atoms, yet muſt the ſame be Defined by the Capacity of the World, i. e. of the Univerſe, as hath been formerly intimated. And, therefore, the common Objection, that if ſo, the ſumme of things exiſtent in the World, would be Finite; is what we moſt willingly admit, there being no neceſſity of their Infinity, and a copious ſyndrome of reaſons, that preſs the Contrary. And as it is unneceſſary to Nature: ſo likewiſe to her Commentator, the Phyſiologiſt; to whom it ſufficeth, having exploded this delirium of Infinity, to ſuppoſe (1) that the material Principles of the Univerſe are eſſentially Figurate, (2) that the ſpecies of their figures are incomprehenſible, as to their Variety, (3) that the Number of indiviſible Particles comprehended under each difference of Figures, is alſo incomprehenſible, but not inexhauſtible, as *Epicurus* inconſiderately imagined.

Art. 8. The *Third* Canon, explained, & refuted.

SECT. IV.

Concerning the Motions of Atoms.

TO give the more light to this dark Theorem, we are to præpoſſeſs our Reader with *Two* introductory *Obſervables*; (1) that our præſent inſiſtence upon only the MOTION of Atoms, doth not ſuppoſe our omiſſion of their GRAVITY; but duely include the full conſideration thereof: ſince their Motion is the proper Effect of their Gravity, and that which doth chiefly bring it within the ſphære of our Apprehenſion. (2) That the genuine Atomiſt doth worthily diſavow all Motion, but what *Plutarch* in the name of *Epicurus*, hath defined to be, Μετάβασις ἀπὸ τόπου εἰς τόπον, *Migratio de loco in locum*, the tranſlation of a thing from one place to another. The ſuſpicion of a *Chaſme* in our Diſcourſe, and the Ambiguity imminent from the Æquivocality of the term, Motion, thus maturely prævented: we may more ſmoothly progreſs to our ſhort Animadverſions on the Conceptions of the Ancients, touching the Laſt General Propriety of Atoms, their Congenial and inteſtine Motion.

Art. 1. Two introductory Obſervables.

Art. 2. The Motion of Atoms, according to the General Diſtinction of the Ancients, Two-fold; *viz. Natural*, and *Accidental*: & each of theſe redivided into two different *Species*.

Herein we are to recognize their opinions, that concern (1) the *Multiplicity*, (2) the *Perpetuity* of motions eſſentially competent to Atoms.

As to the FIRST; they have, according to a General Diſtinction, aſſigned to Atoms a Two-fold Motion; (1) *Natural*, whereby an Atom, accord-

ing to the tendency of its essential weight, is carried directly downward: (2) *Accidental*, whereby one Atom justling or arienating against another, is diverted from its perpendicular descendence, and repercussed another way. The Former, they called *Perpendicular*, the other, *Reflex*. The Natural or Perpendicular *Epicurus* hath doubled again into κατὰ σάθμιον, *ad perpendiculum*, or as *Cicero* (*de fato*) interprets it, *ad Lineam*: and κατὰ παρέγκλισιν, *ad Declinationem*. The Accidental, or Reflex hath also, according to the tradition of *Plutarch*, (1. *placit.* 12.) been by him subdivided into κατὰ πληγὴν, *ex plaga, seu ictu*; and κατὰ παλμὸν, *ex concussione*, or rather, *ex Palpitatione*. So that, according to this special Distinction, there must be four different sorts of motions assignable to Atoms.

Art. 3. The summary of *Epicurus* Figment, of the *Perpendicular* Motion of Atoms, without a common *Centre*.

For the *Perpendicular* Motion, we advertise; that *Epicurus* therein had no respect to any *Centre* either of the World, or the Earth; for He conceded none such possible in the Universe, which He affirmed of infinite extent: but to two contrary Regions allowable therein; the one *Upward*, from whence, without any *terminus à quo*, Atoms flowed; the other *Downward*, toward which, without any *terminus ad quem*, in a direct line they tended. So that, according to this wild dream, any coast from whence Atoms stream, may be called *Above*, and any to which they direct their course, *Below*; insomuch as He conceited the superfice of the Earth, on which our feet find the Centre of Gravity in standing or progression, to be one continued plane, and the whole Horizon above it likewise a continued plane running on in extent not only to the Firmament, but the intire immensity of the Infinite Space. According to which Delirament, if several weights should fall down from the firmament, one upon *Europe*, another upon *Asia*, a third upon *Africa*, a fourth upon *America*; and their motion be supposed to continue beyond the exteriors of the terrestrial Globe: they could not meet in the Centre thereof, but would transfix the four quarters in lines exquisitely parallel, and still descend at equal distance each from other, untill the determination of their motion in the infinite Space, by the occurse and resistence of other greater Weights.

Art. 4. His *Declinatory* natural Motion of Atoms, excused; not justified.

For the *Declinatory* Motion; we observe, that *Epicurus* was by a kind of seeming necessity constrained to the Fiction thereof; since otherwise He had left his fundamental Hypothesis manifestly imperfect, his Principles destitute of a Cause for their Convention, Conflictation, Cohærence, and consequently no possibility of the emergency of Concretions from them. And, therefore, to what *Cicero* (*in* 1. *de fin.*) objects against him, viz. that he acquiesced in a supposition meerly *præcarious*, since he could assign no *Cause* for this motion of Declination, but usurped the indecent liberty of endowing his Atoms with what Faculties he thought advantagious to the explanation of Natures Phænomena in Generation and Corruption: we may modestly respond, by way of excuse not justification, that such is the imbecillity of Human understanding, as that every Author of a physiological Fabrick, or mundane Systeme, is no less obnoxious to the same objection, of præsuming to consign Provinces (for the phrase of *Cicero*, is *dare provincias principiis*) to his Principles, then *Epicurus*. For, in Concretions or Complex Natures, to determine on a reason for this or that sensible Affection, is no desperate difficulty; since the condition of

of præassumed Principles may afford it: but, concerning the originary Causes of those Affections inhærent in and congenial to the Principles of those Concretions, all we can say, to decline a downright confession of our ignorance, is no more then this, that such is the necessity of their peculiar Nature; the proper and germane διὸ ὅτι remaining in the dark to us, and so our Curiosity put to the shift of simple Conjecture, unless we level our thoughts above Principles, and acknowledge no term of acquiescence. And even the acute and perspicacious *Cicero*; notwithstanding his reprehension of it in *Epicurus*, is forced to avow the inevitability of this Exigent, in express words, thus; *Ne omnes à Physicis irrideamur, si dicamus quicquam fieri sine Causa distinguendum est, & ita dicendum; ipsius Individui hanc esse naturam, ut pondere & gravitate moveatur, eamque ipsam esse Caussam; cur ita feratur, &c.* Nor is this Crime of consigning provinces to his Principles, proper only to *Epicurus*; but common also to the *Stoick*, *Peripatetick*, &c. since none of them hath adventured upon a reason of the Heat of Fire, the Cold of Water, the Gravity of Earth, &c. Doubtless, had *Cicero* been interrogated, Why all the Starrs are not carried on in a motion parallel to the Æquator, but some steer their course obliquely; why all the Planets travel not through the Ecliptick, or at least in a motion parallel thereto, but some approach it obliquely: the best answer He could have thought upon, must have been only this, *ita Naturæ leges ferebant*; which how much beseeming the perspicacity of a Physiologist more then to have excogitated Fundamentals of his own, endowed with inhærent Faculties to cause those diverse tendencies, we referr to the easie arbitration of our Reader.

Art. 5. The genuine sense of *Epicurus*, in his distinction of the *Reflex* Motion of Atoms; into *ex Plaga*; & *ex Concussione*.

Concerning the *Accidental*, or *Reflex* Motion, all that is worthy our serious notice, is only this; that when *Epicurus* subdivideth this Genus into two species, namely κατὰ πληγὴν, *ex plaga*, and κατὰ πάλμον, *ex concussione*, and affirmeth that all those Atoms which are (ἄνω κινόμενα) moved *upward*, pursue both sorts of this Reflex tendency; we are not to understand him in this sense, that both these kinds of Reflex motion are opposite to the Perpendicular, since it is obvious to every man, that Atoms respective to their Direct, or Oblique incidence in the different points of their superfice, may make, or rather suffer or direct, or oblique resilitions, and *Epicurus* expresly distinguisheth the Motion from Collision or Arietation into that which pointeth *upward*, and that which pointeth *sidewayes*; but in this, that he might constitute a certain Generical Difference, whereby both the species of Reflex motion might be known from both the species of the Perpendicular. For the further illustration of this obscure Distinction, and to prævent that considerable Demand, which is consequent thereto, viz. *Whether all the possible sorts of Reflex Motion are only two, the one directly Upward, the other directly Lateral:* we advertise, that *Epicurus* seems to have alluded to the most sensible of simple Differences in the Pulse of Animals. For, as *Physitians*, when the Pulsifick Faculty distends the Artery so amply, and allows so great a space to the performance of both those successive contrary motions, the Diastole and Systole, as that the touch doth apprehend each stroke fully and distinctly, denominate that kind of Pulse, πληγὴ; and on the contrary, when the vibrations of the Artery are contracted into a very little space as well of the

ambient, as of time, so as they are narrow and confusedly præsented to the touch, they call it παλμος: so likewise *Epicurus* terms that kind of Rebound, or Resilition, which by a strong and direct incurse and arietation of one Atom against another, is made to a considerable distance, or continued through a notable interval of space, κατ' πληγὴν; and, on the contrary, that which is terminated in a short or narrow interval (which comes to pass, when the resilient Atom soon falls foul upon a second, and is thereby reviberated upon a third, which repercusseth it upon a fourth, whereby it is again bandied against a fifth, and so successively agitated, until it endure a perfect *Palpitation*) he styles κατ' παλμόν. Upon this our Master *Galen* may be thought to have cast an eye, when he said (*lib. de facult. nat.*) it was the opinion of *Epicurus*, *Omnes attractiones per resilitiones atque implexiones Atomorum fieri* that all Attractions were caused by the Resilitions and Implexions of Atoms. Which eminent passage in *Galen*, not only assisted, but interpreted by another of *Plato* (*Magnetem non per Attractionem, sed Impulsionem agere, in Timæo*) of the same import; hath given the hint to *Des Cartes*, *Regius*, Sir *K. Digby*, and some other of our late Enquirers, of supposing the Attractive, rather *Impulsive* Virtue of the Loadstone, and all other bodies Electrical, to consist in the Recess, or *Return* of those continued Effluvia, or invisible filaments of streated Atoms, which are unceßantly exhaled from their pores. Nor doth He much strain these words of *Gilbert* [*Effluvia illa tenuiora concipiunt & amplectuntur corpora, quibus Uniuntur, & Electris, tanquam extensis brachiis, & ad fontem prope invalescentibus effluviis, deducuntur*] who hath charged them with the like signification.

Art. 6. The several Conceptions of *Epicurus*, about the *perpetual* Motions of Atoms.

As to the SECOND, *viz.* the *Perpetuity* of these Motions adscribed to Atoms; we think it not a little material to give you to understand, at least to recognize that the conceptions of *Epicurus* concerning this particular, are cozen Germans to Chimæra's, and but one degree removed from the monstrous absurdities of Lunacy. For, He dreamt, and then believed, that all Atoms were from all Eternity endowed, by the charter, of their uncreate and independent Essence, with that ingenite Vigour, or internal Energy, called Gravity, whereby they are variously agitated in the infinite space, without respect to any Centre, or General term of Consistence: so as they could never discontinue that natural motion, unless they met and encountred other Atoms, and were by their shock or impulse deflected into another course. That the Dissilient or deflected Atoms, whether rebounding upwards directly, or *ad latus* obliquely, or in any line intercedent betwixt those two different regions, would also indefinently pursue that begun motion, unless they were impeded and diverted again by the occurse and arietation of some others floating in the same part of space. And, that because the Revibrations, or Resilitions of Atoms regarding several points of the immense space, like Bees variously interweaving in a swarm, must be perpetual: therefore also must they never quiesce, but be as variously and constantly exagitated even in the most solid or adamantine of Concretions, though the sense cannot deprehend the least inquietude or intestine tumultuation therein; and the rather in respect of those Grotesques or minute Inanities densely intermixed among their insensible particles.

Art. 7. The perpetual *Inquietude* of Atoms, even in compact Concretions, adumbrated in *melted Lead.*

To explicate this Riddle, we must præsent some certain adumbration of this intestine æstuation or commotion of Atoms in Concretions; and this

this may moſt conveniently be done in melted Mettals, as particularly in Lead yet floating in the Fuſory veſſel. To apparence nothing more quiet and calm: yet really no quickſand more internally tumultuated. For, the inſenſible particles of Fire having penetrated the body of the crucible, or melting pan, and ſo permeating the pores of the Lead therein contained; becauſe they cannot return back upon the ſubjacent fire, in regard they are unceſſantly impelled by other ingeneous particles continually ſucceeding on their heels, therefore are they ſtill protrüded on, untill they diſunite all the particles of the Lead, and by the pernicity and continuation of this their ebullition, hinder them from mutual revinction and coaleſcence: and thereby make the Lead a fluid, of a compact ſubſtance, and ſo keep it, as long as the ſuccuſſion of igneous particles is maintained from the fire underneath. During this act of Fuſion, think we, with what violence or pernicity the Atoms of Fire are agitated up and down, from one ſide to another, in the ſmall inanities interſperſed among the particles of the Lead; otherwiſe they could not diſſolve the compact tenour thereof, and change their poſitions ſo as to introduce manifeſt Fluidity: and, ſince every particle of the Lead, ſuffers as many various concuſſions, repercuſſions, and repeated vibrations, as every particle of Fire; how great muſt be the Commotion on both ſides, notwithſtanding the ſeeming quiet in the ſurface of the Lead?

Art. 8. The ſame more ſenſibly exemplified, in the ſpirit extracted from *Mercury*, *Tin*, and *Sublimate*:

But, becauſe our ſenſe, as well as our Reaſon, may have ſome ſatisfaction, touching the perpetual Commotion of Atoms, even in Compoſitions; we offer to Exemplifie the ſame either in the *Spirit* of *Halinitre*, or that which Chymiſts uſually extract from *Crude Mercury*, *Tin*, and *Sublimate* codiſſolved in a convenient menſtruum: For, either of theſe Liquors being cloſe kept in a luted glaſs, you may plainly perceive the minute moleculæ, or ſeminarie conventions of Atoms, of which it doth conſiſt, to be unceſſantly moved every way, upward, downward, tranſverſe, oblique, &c. in a kind of fierce æſtuation, as if goaded on by their inhærent Motor, or internal impulſive Faculty, they attempted ſpeedy emergency at all points, moſt like a multitude of Flyes impriſoned in a glaſs Vial.

Art. 9. The *Mutability* of all Concretions, a good Argument of the perpetual inteſtine Commotion of Atoms, in the moſt adamantine Compoſitions.

Now, the *Argument* that ſeems to have induced *Epicurus* to concede this perpetual Inquietude of Atoms, was the *inevitable mutation of all Concrete Subſtances*, cauſed by the continual Acceſs and Receſs of their inſenſible particles. For, indeed, no Concretion is ſo compact and ſolid, as not to contain within it ſelf the poſſible Cauſes of its utter Diſſolution; yea, though it were ſo immured in Adamant, as to be thought ſecure from the hoſtile invaſion of any Extrinſecal Agent whatever. And the ruine of ſolid bodies (i. e. ſuch whoſe parts are of the moſt compact Contexture allowable to Concretions,) cannot be ſo reaſonably adſcribed to any Cauſe, as this; that they are compacted of ſuch Principles, as are indefinently motive, and in perpetual endeavour of Emergency or Exſilition: ſo that never deſiſting from internal evolutions, circumgyrations, and other changes of poſition; they at length infringe that manner of reciprocal Coaptation, Cohæſion, and Revinction, which determined their ſolidity, and thereby diſſolving the Compoſitum, they wholly emancipate themſelves, obey their reſtleſs tendency at randome, and diſappear.

Art. 10. What we are to *explode*, and what *retain*, in the opinion of *Epicurus*, touching the Motion of Atoms.

This fæculent Doctrine of *Epicurus*, we had occaſion to examine and refine all the droſs either of Abſurdity, or Atheiſm, in our Chapter concerning

cerning the *Creation of the World ex nihilo,* in our Book against *Atheism.* However, we may not dismiss our Reader without this short Animadversion. The Positions to be exploded are (1) *That Atoms were Eternally existent in the infinite space,* (2) *that their Motive Faculty was eternally inherent in them, and not derived by impression from any External Principle,* (3) *that their congenial Gravity affects no Centre,* (4) *that their Declinatory motion from a perpendicular, is connatural to them with that of perpendicular descent, from Gravity.* Those which we may with good advantage substitute in their stead, are (1) *That Atoms were produced* ex nihilo, *or created by God, as the sufficient Materials of the World, in that part of Eternity, which seemed opportune to his infinite Wisdom;* (2) *that, at their Creation, God invigorated or impregnated them with an Internal Energy, or Faculty Motive, which may be conceived the First Cause of all Natural Actions, or Motions,* (for they are indistinguishable) *performed in the World;* (3) *that their gravity cannot subsist without a Centre;* (4) *that their internal Motive Virtue necessitates their perpetual Commotion among themselves, from the moment of its infusion, to the expiration of Natures lease.* For, by virtue of these *Correctives,* the poisonous part of *Epicurus* opinion, may be converted into one of the most potent *Antidotes* against our Ignorance: the *Quantity* of Atoms sufficing to the Materiation of all Concretions; and their various *Figures* and *Motions* to the Origination of all their *Qualities* and *Affections,* as our immediately subsequent Discourse doth professedly assert.

The

The Third Book.

CHAP. I.

The Origine of Qualities.

SECT. I.

THat the ſounding Line of Mans Reaſon is much too ſhort to profound the *Depths*, or Channels of that immenſe Ocean, *Nature*; needs no other evictment but this; that it cannot attain to the bottom of Her *Shallows*. It being a diſcouraging truth, that even thoſe things, which are familiar and within the ſphere of our *Senſe*, and ſuch to the clear diſcernment whereof we are furniſhed with Organs moſt exquiſitely accommodate; remain yet ignote and above the Moon to our *Underſtanding*. Thus, what can be more evident to ſenſe, then the *Continuity* of a Body: yet what more abſtruſe to our reaſon, then the *Compoſition* of a *Continuum*? What more obviouſly ſenſible then *Qualities*: and yet what problem hath more diſtracted the brains of Philoſophers, then that concerning their *Unde*, or *Original*? Who doth not know, that all Senſation is performed by the Mediation of certain Images, or Species: yet where is that He, who hath hit the white, in the undoubted determination of the Nature of a ſpecies, or apodictically declared the manner of its Emanation from the Object to the Senſorium, what kind of inſenſible-ſenſative impreſſion that is, which it maketh thereupon, and how being from thence, in the ſame

Art. 1. An introductory Advertiſement; of the *obſcurity* of many things to *Reaſon*, which are *manifeſt* to *ſenſe*: and of the *Poſſibility*, not neceſſity of the Elementation of *Concretions*, and their ſenſible *Qualities*, from the Principles præſumed.

ſame inſtant tranſmitted to that noble *ſomething* within us, which we underſtand not, it proves a lively *Tranſumpt*, or type, and informs that ready judge of the Magnitude, Figure, Colour, Motion, and all other apparences of its *Antitype* or Original? or, what hath ever been more manifeſt or beyond dubitation, then the reality of *Motion*? and yet we dare demand of *Galilæo* himſelf, what doth yet remain more imperveſtigable, or beyond apodictical deciſion, then the *Nature* and *Conditions* thereof.

Concerning the *Firſt* of theſe 4 ænigmatical Quæſtions, we have formerly præſented you no ſparing account of our Conjectural opinion: which we deſire may be candidly accepted in the latitude of *Probability* only, or how it *may* be, rather then how *it is*, or *muſt* be; i. e. that it is, though moſt *poſſible* and *veriſimilous* that every Phyſical Continuum ſhould conſiſt of Atoms; yet not abſolutely *neceſſary*. For, inſomuch as the true Idea of Nature is proper only to that *Eternal Intellect*, which firſt conceived it: it cannot but be one of the higheſt degrees of madneſs for dull and unequal man to prætend to an exact, or adæquate comprehenſion thereof. We need not advertiſe, that the Zenith to a ſober Phyſiologiſts ambition, is only to take the copy of Nature from her ſhadow, and from the reflex of her ſenſible Operations to deſcribe her in ſuch a ſymmetrical Form, as may appear moſt plauſibly ſatisfactory to the ſolution of all her Phænomena. Becauſe 'tis well known, that the eye of our grand Maſter *Ariſtotles* Curioſity was levelled at no other point, as himſelf ſolemnly profeſſeth (*in Meteorolog. lib.*1. *cap.* 7. *initio*) in theſe words: Ἐπεὶ δὲ περὶ τῶν ἀφανῶν τῆς αἰσθήσεως νομίζομεν ἱκανῶς ἀποδεδεῖχθαι καλῶς τὸν λόγον, ἐὰν εἰς τὸ δυνατὸν ἀναγάγωμεν, ἔκ τε τῶν νῦν φαινομένων ὑπολάβοι τις ἄν, εἴ τι περὶ τούτων μάλιστα συμβαίνειν: i. e. *Cum autem de hiſce, quæ ſenſui pervia non ſunt, ſatis eſſe juxta rationem demonſtratum putemus, ſi ad id quod fieri poſſit ea reduxerimus, ex hiſce quæ in præſentia dicuntur, exiſtimaverit quiſpiam de hiſce maximè ad hunc modum uſu venire.* And evident it is that *Monſ. Des Cartes* never was more himſelf, that is, profoundly ingenious, then when he crowned his excellent Principles of Philoſophy with this advertiſement: *at quamvis fortè hoc pacto intelligatur, quomodo res omnes naturales fieri potuerint; non tamen ideo concludi debet, ipſas reverà ſic factas eſſe: & ſatis à me præſtitum eſſe putabo, ſi tantum ea quæ ſcripſi, talia ſint, ut omnibus Naturæ Phænomenis accuratè reſpondeant; hoc enim ad uſum vitæ ſufficiet.*

And, concerning the *other three*, which according to the natural order of their dependence, are ſucceſſively the Arguments of our next enſuing Exercitations; we likewiſe deprecate the ſame favourable interpretation, in the General: that ſo, though our attempts perhaps afford not ſatisfaction to others, yet they may not occaſion the ſcandal of *Arrogance* and *Obſtinacy* in opinion to our ſelves.

Art. 2. The Authors Definition of a *Quality*, in general: and genuine expoſition of *Democritus* myſterious Text, concerning the *Creation* of *Qualities*.

By the *Quality* of any Concretion, we underſtand in the General, no more but that *kind of Apparence, or Repreſentation, whereby the ſenſe doth diſtinctly deprehend, or actually diſcern the ſame, in the capacity of its proper Object.* An *Apparence* we term it, becauſe the *Quale* or *Suchneſs* of every ſenſible thing, receives its peculiar determination from the relation it holds to that ſenſe, that peculiarly diſcerns it: at leaſt from the judgment made in the mind according to the evidence of ſenſation. Which doubtleſs

was

was the genuine intent of *Democritus* in that remarkable and mysterious text, recorded by *Galen* (*in lib. 1. de Element. cap. 2.*) thus: Νόμῳ χροιὴ, νόμῳ πικρὸν, νόμῳ γλυκὺ; ἐτεῇ δ' ἄτομον, καὶ κενὸν ὁ δημόκριτος φησὶν ἐκ τῆς ζωόδους τῆς ἀτόμων γίνεσθαι νομίζων ἁπάσας τὰς αἰσθητὰς ποιότητας, ὡς πρὸς ἡμᾶς τοὺς αἰσθανομένους αὐτῶν, φύσει δὲ οὐδὲν εἶναι λευκὸν, ἢ μέλαν, ἢ ξάνθον., &c. *Lege enim Color, lege amaror, lege dulcor; revera autem Atomus, & Inane, inquit Democritus, existimans omneis Qualitates sensibileis ex Atomorum concursu gigni, quatenus se habent ad nos; qui ipsarum sensum habemus: Natura autem nihil candidum esse, aut flavum, aut rubrum, &c.* The importance of which may be fully and plainly rehdred thus; that since nothing in the Universe stands possessed of a Real or True Nature, i.e. doth constantly and invariately hold the præcise Quale, or Suchness of their particular Entity, to Eternity; Atoms (understand them together with their essential and inseparable Proprieties, lately specified.) and the Inane Space only excepted: therefore ought all other things, and more eminently Qualities, in regard they arise not from, nor subsist upon any indeclinable necessity of their Principles, but depend upon various transient Accidents for their existence, to be reputed not as absolute and entire Realities, but simple and occasional Apparences, whose specification consisteth in a certain modification of the First Matter, respective to that distinct Affection they introduce into this or that particular sense, when thereby actually deprehended. Not that *Democritus* meant, in a litteral sense, that their production was determinable *ex instituto hominum*, by the opinionative laws of mans Will; as most of his Commentators have inconsiderately descanted: but in a *Metaphorical*, that as the justice, injustice, decency, turpitude, culpability, laudability of Human actions, are determined by the Conformity or Difformity they bear to the Constitutions Civil, or Laws generally admitted, so likewise do the whiteness, blackness, sweetness, bitterness, heat or cold, of all Natural Concretions receive their distinct essence, or determination from certain positions and regular ordinations of Atoms. And this easily hands us to the natural scope of that passage in *Laertius*; Ἀρχὰς εἶναι τὴν ὅλων ἄτομον, καὶ κενὸν, τὰ δ' ἄλλα πάντα νενομίσθαι, *Esse Atomos & Inane Universorum principia, cætera omnia Lege sanciri:* as also of another in *Empiricus* (1. *hypot.* 30.) ἐτεῇ Ἄτομα καὶ κενὸν, *VERE esse Insectilia ac Inane.* However, if any please to prefer the exposition of *Magnenus*, that *Democritus* by that unfrequent and gentilitious phrase, *Nemo esse Qualitates*, would have the determinate nature of any Quality to consist *in certa quadam lege, & proportione inter agens & patiens*, in a certain proportion betwixt the Agent and Patient, or object and sensorium; we have no reason to protest against his election. For we shall not deny, but what is *Hony* to the palate of one man, is *Gall* to another; that the most delicious and poynant dishes of *Europe*, are not only insipid but loathsome to the stomachs of the *Japones*, who in health eat their Fish boyled, and in sickness raw, as *Maffeus* (*in libro de Japonum moribus*) reports; that some have feasted upon Rhubarb, Scammony, and Esula, which most others are ready to vomit and purge at the sight of; that Serpents are dainties to Deer, Hemlock a perfect Cordial to Goats, Hellebor a choyce morsel to Quails, Spiders restorative to Monkeys, Toads an Antidote to Ducks, the Excrements of man pure Ambre Grise to Swine, &c. All which most evidently declare the necessity of a certain proportion or Correspondence betwixt the object and particular organ of sense, that is to apprehend and judge it.

But ſince the Notion of a *Quality* is no rarity to common apprehenſion, every Clown well underſtanding what is ſignified by *Colour*, *Odour*, *Sapour*, *Heat*, *Cold*, *&c.* ſo far as the concernment of his ſenſe we are no longer to ſuſpend our indagation of their poſſible ORIGINE, in the general.

Art. 3. The neceſſary deduction of Qualities from *Naked* or *Unqualified* Principles.

Which, were our Atoms identical with the *Homoiomerical* Principles of *Anaxagoras* formerly deſcribed, and exploded; might be thought a task of no difficulty at all: in regard thoſe Conſimilarities are ſuppoſed actually to contain all Qualities, in the ſimplicity of their nature, or before their Convention and Diſpoſition into any determinate Concretion; i. e. that Colour, Odour, Sapor, Heat, Cold, &c. ariſe from Colorate, Odorate, Sapid, Hot, Cold particles of the Firſt Catholique Matter. But, inſomuch, as *Atoms*, if we except their three congenial Proprieties, *viz.* Magnitude (which by a general intereſt, retains to the Category of Qualities) Figure, and Motion; are unanimouſly aſſumed to be *Exquales*, ſeu *Qualitatis Expertes*, abſolutely devoid of all Quality: it may ſeem, at firſt encounter, to threaten our endeavors with infelicity, and damp Curioſity with deſpair of ſatisfaction. And yet this Giant at diſtance, proves a mere Pygmie at hand. For, the *Nakedneſs*, or *Unqualifiedneſs* of Atoms, the point wherein the whole Difficulty appears radicated; to a cloſer conſideration muſt declare it ſelf to be the baſis of our exploration, and indiſpenſably neceſſary to the Deduction of all ſenſible Qualities from them, when diſpoſed into Concrete Natures. Becauſe, were any Colour, Odour, &c. eſſentially inhærent in Atoms; that Colour, or Odour muſt be no leſs intranſmutable then the ſubject of its inhæſion: and that Principles are Intranſmutable, is implied in the notion of their being Principles; for it is of the formal reaſon of Principles, conſtantly to perſever the ſame in all the tranſmutations of Concretions. Otherwiſe, all things would inevitably, by a long ſucceſſion of Mutations, be reduced to clear Adnihilation. Beſides, all things become ſo much the more Decoloured, by how much the ſmaller the parts are into which they are divided; as may be moſt promptly experimented in the pulverization of painted Glaſs, and pretious ſtones: which is demonſtration enough, that their Component Particles, in their Elementary and diſcrete capacity, are perfectly deſtitute of Colour. Nor is the force of this Argument reſtrained only to Colour, as the moſt eminent of Qualities ſenſible: but extenſible alſo to all others, if examined by an obvious inſiſtence upon particulars.

Art. 4. The two primary *Events* of Atoms, *viz.* *Order* and *Poſition*, aſſociated to their three eſſential *Proprieties*, viz. *Magnitude*, *Figure*, and *Motion*; ſufficient to the Origination of all Qualities.

Now, having taken footing on the neceſſary Incompetence of any ſenſible Quality to the Material Principles of Concretions: we may ſafely advance to our Inveſtigation of the Reaſon, or Manner how Colour, and all other Qualities may be educed from ſuch naked and unqualified Principles. And firſt we muſt have recourſe to ſome few of the moſt conſiderable EVENTS conſignable to Atoms, as well as to their 3 inſeparable Proprieties. The primary, and to this ſcope, moſt directly pertinent Events of Atoms, are only two, *viz.* τάξις καὶ θέσις, ORDER and SITUATION. That *Leucippus* and *Democritus*, beſides thoſe two eminent events, Σύγκρισις καὶ διάκρισις, *Concretion*, and *Secretion*, from which the *Generation* and *Corruption* of all things are derived; have alſo attributed unto Atoms; two other as requiſite to all *Alteration*, i. e. the procreation of various Qualities, namely *Order* and *Poſition*: is juſtifiable upon the teſtimony

mony of *Aristotle* (*in lib. de ortu & interitu*) however He was pleased (*in* 8. *Metaphys. cap.* 2.) interpreting the Abderitane terms of *Democritus*, to adnumerate τὸ σχῆμα, *Figure*, unto them, and thereupon inferr that Atoms are different, ἢ ῥυσμῷ, ὅ ἐστι σχῆμα; ἢ τροπῇ, ὅ ἐστι θέσις, ἢ διαθιγῇ, ὅ ἐστι τάξις, i. e. *aut Rhysmo, quod est Figura; aut Trope, quod est situs; aut Diathege, quod est ordo*: & (*in Metaphys.* 1. *cap.*4.) to exemplifie this difference in Letters of the Alphabet; saying that A and N differ in Figure; A N, and N A, in order; and Z N, in situation. Which is the same with what *Empiricus* (2.*advers.phys.*) reports to have been delivered by *Epicurus*. True it is, his Disciple *Lucretius*, exceeded him in the number of *Events* assignable to Atoms, in order to the emergency of all sensible Qualities from them; for he composing this Distich

Intervalla, Vias, Connexus, Pondera, Plagæ,
Concursus, Motus, Ordo, Positura, Figuræ,

confounds both *Events* and *Conjuncts* together: wherein He seems to have had more regard to the smoothness of his Verses, then the Methodical traction of his Subject. For, *Motion*, *Concurse*, and *Percussion* are the natural Consequents of *Gravity*: and *Distance* and *Connexion* are included in *Position*; and *Wayes* or Regions belong to *Order*, as may be exemplified in the former Letters, which respective to their remote or Vicine Position, and their Change from the right to the left hand, exhibite to the sense various faces or apparences.

Art. 5. The necessity of assuming the *Magnitude* and *Motion* of Atoms, together with their *Order* and *Situation*, as to their production of Qualities, evicted by a double instance.

That those two Conjuncts, *Magnitude* and *Motion*, are necessarily to be associated to Order and Position; is evident from hence, that if it be enquired, why there is in Light so great a subtility of parts, as that in an instant it penetrates the thickest Glass; but so little in Water, as that it is terminated in the superfice thereof: what more verisimilous reason can be alledged to explain the Cause of that difference in two fluid bodies, then this, that the Component Particles of Light are more minute, or have less of Magnitude, then those of Water? And if it be enquired, why the Aer, when agitated by the wind, or a fan, appears Colder, then when quiet: what solution can be more satisfactory, then this, that by reason of its motion it doth more deeply penetrate the pores of the skin, and so more vigorously affect the sense? However, if we confine our assumption only to these three Heads, *Figure*, *Order*, and *Position*; we shall yet be able, without much difficulty, to make it out, how from them, either single, or diversly commixt, an infinite Multiplicity of Qualities may be created; as may be most appositely explained by the Analogy which Letters hold to Atoms. For as *Letters* are the *Elements* of *Writing*, and from them arise by gradation, Syllables, Words, Sentences, Orations, Books: so proportionately are *Atoms* the *Elements* of *Things*, and from them arise by gradation, most exile Moleculæ, or the Seminaries of Concretions, then greater and greater Masses successively, until we arrive at the highest round in the scale of Magnitude.

Art. 6. The *Figure*, *Order* and *Position* of Parts in Concretions, alone sufficient to the Caussation of an indefinite variety of Qualities, from the analogy of Letters.

But we are restrained to an insistence only upon our 3 Heads assumed. As Letters of divers Figures, U, G, A, E, O, when præsented to the eye, carry 3 different species, or aspects; and when pronounced, affect the Ear with as many distinct sounds: exactly so do Atoms, respectively to the variety

riety of their Figures, and determinate Contexture into this or that ſpecies, occurring to the Organs of Sight, Hearing, Smelling, Taſting, Touching, make divers impreſſions thereupon, or præſent themſelves in divers Apparences, or (what is tantamount) make divers Qualities. (2) As one and the ſame Letter diverſly poſited, is divers to the Sight, and Hearing, as may be inſtanced in Z, N, y, λ, b, d, p, q: ſo likewiſe doth one and the ſame Atom, according to its various poſitions, or faces, produce various affections in the Organs of Senſe. For inſtance, if the Atome aſſumed be Pyramidal: when the Cone is obverted to the ſenſory Organ, it muſt make a different impreſſion upon it, from that which the Baſe, when obverted and applyed, will cauſe. (3) As the ſame two three or more Letters, according to their mutation of Site, or Anteceſſion and Conſequution, impart divers words to the eye, divers ſounds to the ear, and divers things to the mind; as ET, TE, IS, SI, SUM, MUS, ROMA, AMOR, MARO, RAMO, ORAM, MORA, ARMO, &c. ſo alſo may two three, or more Atoms, according to their various poſitions and tranſpoſitions, affect the ſenſe with various Apparences, or Qualities. (4) And as Letters, whoſe variety of Figures exceeds not thoſe of the Alphabet, are ſufficient only by the variety of order, to compoſe ſo great diverſity of words, as are contained in this, or all the Books in the World: ſo likewiſe, if there were but 24 diverſe Figures competent to Atoms, they alone by variety of Order, or tranſpoſition, would ſuffice to the conſtitution of as incomprehenſible a diverſity of Qualities. But, when the diverſity of their Figures is incomparably greater: how infinitely more incomprehenſible muſt that variety of Qualities be, which the poſſible changes of their Order may produce?

Art. 7. The ſame Exemplified in the ariſe of *White Froth*, on the Waves of the Sea.

Thus in the Water of the Sea, when agitated into a white froth, no other mutation is made, ſave only the ſituation and differing contexture of the parts thereof diſpoſed by the included aer into many ſmall bubbles; from which the incident rayes of Light (which otherwiſe would not have been reflected in united) and direct ſtreams to the eye, and ſo creat a whiteneſs continued, which is but paler, or weaker light, which muſt diſappear immediately upon the diſſolution of the bubbles, and return of the parts of the water to their natural conſtitution of fluidity.

Art. 8. The Nativity of *Colours* in General, explained by ſeveral obvious Examples.

And ſince we are fallen upon that eminent Quality, *Colour*; we ſhall illuſtrate the obſcure nativity thereof, in the general, by a moſt prægnant example. Immerge into a Glaſs Vial of clean fountain Water, ſet upon warm embers, half an ounce (more or leſs, according the quantity of Water) of the leaves of Senna; and after a ſmall interval of time, inſtill into the infuſion a few drops of the oil of Tartar made *per Deliquium*, which done, you ſhall perceive the whole mixture to become Red. Now, ſeeing that no one of the three ingredients, in their ſimple and divided ſtate, do retain to that ſpecies of Colour, in the remoteſt degree of affinity; from what original can we derive this emergent Redneſs? Doubtleſs, only from hence; that the Water doth ſo penetrate, by a kind of Diſcuſſion ſeparate, and educe the ſmaller particles of that ſubſtance, whereof the leaves of Senna are compoſed, as that the particles of the oyl of Tartar ſubtily permeating the infuſion, totally after the Contexture thereof, and ſo commove and convert its minute diſſolved particles, as that the rayes of Light from without falling upon them,

them, ſuffer various refractions and reflections from their ſeveral obverted faces, and præſent themſelves to the eye in the apparence of that particular Colour. And to confirm you herein; you need only inſtead of oyl of Tartar, infuſe the like proportion of oyl of Vitriol into the ſame Tincture of Senna: for, thereupon no ſuch redneſs at all will ariſe to the compoſition. Which can be ſolved by no better a reaſon than this; that the oyl of Vitriol wants that virtue of commoving and converting the educed particles of the Senna into ſuch poſitions and order, as are determinately requiſite to the incidence, refraction, and reflection of the rayes of Light to the eye, neceſſary to the creation of that Colour. On the Contrary, inſtead of Senna, infuſe Roſe leaves in the Water, and ſuperaffuſe thereto a few drops of the Spirit of Vitriol: and then the infuſion ſhall inſtantly acquire a purple tincture, or deep ſcarlet; when from the like or greater quantity of oyl of Tartar inſtilled, no ſuch event ſhall enſue. Both which Experiments collated are Demonſtration ſufficient, that a Red may be produced from ſimples abſolutely deſtitute of that gloſs, only by a determinate Commixture, and poſition of their inſenſible particles: no otherwiſe then as the ſame Feathers in the neck of a Dove, or train of a Peacock, upon a various poſition of their parts both among themſelves, and toward the incident Light, præſent various Colours to the eye; or as a peice of Changeable Taffaty, according as it is extended, or plicated, appears of two different dyes. The ſame may alſo be conceived of the Cærule Tincture cauſed in White Wine by *Lignum Nephriticum* infuſed when the Decoction thereof ſhall remain turbid and ſubnigricant.

Moreover, leſt we leave you deſtitute of Examples in the other 4 orders of Qualities, reſpondent to the 4 remaining ſenſes, to illuſtrate the ſufficiency of Figure, Order and Situation, to their production; be pleaſed to obſerve.

Art. 9. The Accenſion of *Heat*, from Concretions actually Cold, upon a meer tranſpoſition of their Component Particles; exemplified in ſundry Chymical Experiments.

Firſt, that *Lead* calcined with the *ſpirit* of the moſt eager *Vinegre*, ſo ſoon as it hath imbibed the moyſture of the ambient aer, or be irrigated with a few drops of Water, will inſtantly conceive ſo intenſe a *heat*, as to burn his finger that ſhall touch it. Now, ſince both the Calcined Lead and Water are actually Cold, and no third Nature is admixt, and nothing more can be ſaid to be in them when commixt, that was in them during their ſtate of ſeparation; whence can we deduce that intenſe Heat, that ſo powerfully affecteth, indeed, miſaffecteth the ſenſe of *Touching?* Quæſtionleſs, only from this our *triple fountain*, i. e. from hence, that upon the acceſſion of humidity, the acute or pointed particle of the ſpirit of Vinegre, (whereby the fixed ſalt of the Lead was, by potential Calcination, diſſolved, and the Sulphur liquated) change their order and ſituation, and after various convolutions, or the motions of Fermentations, obvert their points unto, and penetrate the skin, and ſo cauſe a dolorous Compunction, or diſcover themſelves to the Organ of Touching in that ſpecies of Quality, which men call Heat. The reaſon of this Phænomenon is clearly the ſame with that of a heap of *Needles*; which when confuſed in oblique, tranſverſe, &c. irregular poſitions, on every ſide prick the hand that

that graſpeth them : but if diſpoſed into uniform order, like ſticks in a Fagot, they may be laterally handled without any aſperity or puncture : or that of the *Briſtles* of an *Urchine*, which when depreſſed, or ported, may be ſtroked from head to tayle, without offence to the hand; but when erected or advanced, become intractable.

By the ſame reaſon alſo may we comprehend, why *Aqua Fortis*, whoſe Ingredients in their ſimple natures are all gentle and innoxious, is ſo fiery and almoſt invincible a poyſon to all that take it : why the Spirit of *Vitriol*, freſhly extracted, kindles into a fire, if confuſed with the *Salt* of *Tartar* : why the Filings of *Steel* when irrigated with Spirit of *Salt*, ſuffer an æſtuation, ebullition, and diſſolution into a kind of Gelly, or Paſte : with all other mutations ſenſible, obſerved by Apothecaries and Chymiſts, in their Compoſitions of Diſſimilar natures, from which ſome third or neutral Quality doth reſult.

Art. 10. The Generation of all kinds of ſenſible Qualities in one and the ſame Concretion, from the variegated poſitions of its particles: evidenced in the Example of a *putrid Apple.*

Secondly, that in the parts of an Apple, whoſe one half is rotten, the other ſound, what ſtrange diſparity there is in the points of Colour, Odour, Sapour, Softneſs, &c. Qualities. The ſound half is ſweet in taſte, freſh and fragrant in ſmell, white in Colour, and hard to the touch : the Corrupt, bitter, earthy or cadaverous, duskiſh, or inclinining to black, and ſoft. Now to what Cauſe can we adſcribe this manifeſt diſſimilitude, but only this : that the Particles of the Putrid half, by occaſion either of Contuſion, or Corroſion, as the Procatarctick Cauſe, have ſuffered a change of poſition among themſelves, and admitted almoſt a Contrary Contexture, ſo as to exhibite themſelves to the ſeveral Organs of Senſe in the ſpecies of Qualities almoſt contrary to thoſe reſulting from the ſound half; which upon a farther incroachment of putrefaction, muſt alſo be deturbed from their natural Order, and Situations in like manner, and conſequently put on the ſame Apparences, or Qualities. For, can it be admitted, that the ſound moity, when it ſhall have undergone Corruption, doth conſiſt of other Particles then before? if it be anſwered, that ſome particles thereof are exhaled, and others of the aer ſucceeded into their rooms; our aſſertion will be rather ratified, then impugned : becauſe it præſumes; that from the egreſſion of ſome particles, the ſubingreſſion of others of aer, and the total tranſpoſition of the remaining, Corruption is introduced thereupon; and thereby that general change of Qualities, mentioned.

Art. 11. The aſſenting ſuffrage of *Epicurus.*

Theſe *Inſtances*, and the inſufficiency of any other *Dihoties*, to the rational explanation of them, with due attention and impartiality perpended; we cannot but highly applaud the perſpicacity of *Epicurus*, who conſtantly held, τὴν μεταβλητικὴν κίνησιν, εἶδος εἶναι τῆς μεταβατικῆς, that the Motion of *Mutation* was a ſpecies of *Local Tranſition*: and τὸ γὰρ μεταβαλλον κατὰ ποιότητα σύγκριμα πάντως κατὰ τὴν τῆς συγκεκριμένων, αὐτὸ λόγῳ θεωρητῶν, σωμάτων, τὸ τικὴν τε, καὶ μεταβατικὴν κίνησιν μεταβάλλει : *Concretum, quod ſecundum Qualitatem mutatur, omnino mutatur Locali & tranſitivo motu eorum corporum, ratione intelligibilium, quæ in ipſum concreverint.* Which *Empiricus* (2. *adverſ.*

adverſ. Phyſ.) deſcanting upon, ſaith thus; *Exempli cauſſâ, ut ex dulci fiat aliquid amarum, aut ex albo nigrum; oportet moleculas, ſeu Corpuſcula quæ ipſum conſtituunt, tranſponi, & alium, vice alterius, ordinem ſuſcipere: Hoc autem non contigerit, niſi ipſæ moleculæ, motione tranſitus, moveantur. Et rurſus, ut ex molli fiat quid Durum, & ex duro molle; oportet eas, quæ illud conſtituunt, particulas ſecundum locum moveri: quippe earum extenſione mollitur, coitione verò & condenſatione dureſcit, &c.* All which is moſt adæquately exemplified in a rotten Apple.

And this, we conceive, may ſuffice in the General for our Enquiry into the poſſible Origine of ſenſible Qualities.

CHAP.

CHAP. II.

That Species Visible are SUBSTANTIAL EMANATIONS.

Sect. I.

Art. 1. The Visible Images of objects, *substantial:* and either *corporeal Emanations* from the superficial parts of Concretions; or *Light* it self, disposed into contextures, consimilar to the figure of the object.

Ensus non suscipere SUBSTANTIAS, though the constant assertion of *Aristotle*, and admitted into his Definition of Sense, αἴσθησίς ἐστι τὸ δεκτικὸν τῶν αἰσθητῶν εἰδῶν ἄνευ τῆς ὕλης, *Sensus est id, quod est capax sensibilium specierum sine materia*; (*lib.* 2. *de Anima, cap. ultim.*) and swallowed as an Axiome by most of his *Commentators*: is yet so far from being indisputable, that an intent examination of it by reason may not only suspect, but convict it of manifest *absurdity*. Witness only one, and the noblest of Senses, the SIGHT: which discerns the exterior Forms of Objects, by the reception either of certain *Substantial*, or *Corporeal Emanations*, by the sollicitation of *Light* incident upon, and reflected from them, as it were Direpted from their superficial parts, and trajected through a diaphanous Medium, in a direct line to the eye: or, of *Light it self*, proceeding in streight lines from Lucid bodies, or in reflex from opace, in such contextures, as exactly respond in order and position of parts, to the superficial Figure of the object, obverted to the eye.

Art. 2. The position of their being *Effluviaes*, derived from *Epicurus*; and preferred to the common doctrine of the Schools of the *Immateriality* of Species Visible.

For the FIRST of these Positions, *Epicurus* hath left us so rational a Ground, that deserves, besides our admiration of His Perspicacity, if not our plenary Adhærence, yet at least our calm Allowance of its *Verisimility*, and due prælation to that jejune and frothy Doctrine of the *Schools*; that *Species Visible are Forms without Matter, and immaterial not only in their admission into the Retina Tunica, or proper and immediate Organ of sight; but even in their Trajection through the Medium interjacent betwixt the object*

object and the eye. Which Argument, since too weighty, to be entrusted to the support of a *Gratis*, or simple *Affirmation*; we shall endeavour to prop up with more then one solid *Reason.*

And this that we may, with method requisite to perspicuity, effect: we are to begin at the faithful recital of *Epicurus* Text, and then proceed to the Explanation, and Examination of it.

Art. 3. *Epicurus* Text concerning the same.

Reputandum est, esse in mundo quasdam Effigies, ad Visionem inservientes, quæ corporibus solidis delineatione consimiles, superant longè sua tenuitate quicquid est rerum conspicabilium. Neq; enim formari repugnat etiam in medio aere circumfusove spatio, hujusmodi quasdam Contexturas: uti neque repugnat, esse quasdam in ipsis rebus, & maximè in Atomis, dispositiones, ad operandum ejusmodi spectra, quæ sunt quasi quædam meræ inanesq; Cavitates, & superficiales, soliditatisvè expertes tenuitates. Neq; præterea repugnat, fieri ex Corporibus extimis Effluxiones quasdam Atomorum continenter à volantium in quibus idem positus, idemq; ordo, qui fuerit in solidis, superficiebusvè ipsorum, servetur: ut tales proindè Effluxiones sint quasi Formæ, sive Effigies, & Imagines Corporum, à quibus dimanant. Tales autem Formæ sive Effigies & Imagines sunt, quas moris est nobis, ut Idola, seu simulachra appellitemus. Ex lib. 10. *Diogen. Laertij. & versione Gassendi.*

The importance of which, and the remainder of his judgment, concerning the same theorem, may be thus concisely rendred. Without repugnancy to reason, it may be conceived (1) That in the University of Nature are certain most tenuious Concretions, or subtle Contextures, holding an exquisite analogy to solid bodies. (2) That by these, occurring to the sense, and thence to the Mind, all Vision, and Intellection is made: for they are the same that the Græcian Philosophers call Εἴδολα, καὶ φάσματα, and the Latine *Imagines, Spectra, Simulachra, Effigies*, and most frequently *Species Intentionales.* (3) That among all the sundry possible wayes of the generation of these Species Visible, the two primary and most considerable are (1) by their *Direption* from the superficial parts of Compound bodies, (2) by their *Spontaneous Emanation*, and Concretion in the aer; and therefore those of the First sort are to be named Ἀποφάσεις, and those of the second Συφάσεις. (4) That those Images, which are direpted from the extreams of solid bodies, do conserve in their separated state the same order and position of parts, that they had during their united. (5) That the ineffable or insuperable *Pernicity*, whereby these Images are transferred through a free space, depends upon both the *Pernicity* of the Motion of *Atoms*, and their *Tenuity* or *Exility.* For, the motion of Atoms, while continued through the Inane Space, and impeded by no retundent, is supposed to be inexcogitably swift: nor are we to admit, that when an Atom is repercussed by another directly arietating against it, and afterward variously bandied up and down by the retusion of others encountring it; these partial or retuse motions are less swift, i.e. are performed in a space of time more assignable or distinguishable by thought, then if they were extended into one direct, simple, or uninterrupted motion. And for the second Fundament, the extreme Tenuity of Atoms; insomuch as these Images are præsumed to be no more but certain superficial Contextures of Atoms: it cannot seem inconsequent, that their Pernicity can know no remora. And thus much of *Epicurus Text*; and the competent *Exposition* thereof.

Art. 4. The faithful *Exposition* thereof.

Art. 5. The Contents thereof reduced to 4 *Heads*

It succeeds that we examine the relation it bears to *Probability*; referring the consideration of his *spontaneous* and *systatical* Images, to the Last Section: and reducing our thoughts concerning the *Direpted* and *Apostatical* (which are, indeed, the proper subject of our præsent disquisition) to four capital points, viz. (1) their *An sint*, or Existence; (2) their *Quid sint*, or proper Nature; (3) their *Unde*, or Production; (4) their *Celerity* of Transmission.

Art. 6. The *Existence* of Images visible, certified by autoptical Demonstration.

Of the FIRST, namely the EXISTENCE of Species Visible; this is sufficiently certified by the obvious experience of Looking-glasses, Water, and all other Catoptrick or Speculary bodies: which autoptically demonstrate the Emission of Images from things objected. For, if the object be removed, or eclipsed by the interposition of any opace body, sufficiently dense and crass to terminate them, the Images thereof immediately disappear; if the object be moved, inverted, expansed, contracted, the Image likewise is instantly moved, inverted, expansed, contracted; in all postures conforming to, and so undeniably proclaiming its necessary dependence upon its Antitype. Thus also, when in Summer we shade our selves from the intense fervor of the Sun, in green Arbours, or under Trees; we cannot but observe all our cloaths tincted with a thin Verdure, or shady Green: and this from no other Cause, but that the Images or Species of the Leaves, being as it were stript off by the incident light, and diffused into the vicine Aer, are terminated upon us, and so discolour our vestiments. Not, as *Magirus* would solve it, *qualitate, i.e. immateriali forma, qua aer, corpus* διαφανὲς, *à folijs arborum viridibus imbuitur, tingitur, pingitur*, (*Comment. in Phylologiam Peripat. lib.6.cap.6.num.*27.) And thus are the bodies of men sitting, or walking in a large room, infected with the Colours of the Curtains or Hangings, when the Sun strikes upon them: Of which *Lucretius* thus,

Nam jacier certè, atq; emergere multa videmus,
Non solum ex alto, penitusque, ut diximus ante;
Verum de summis ipsum quoq; sæpe Colorem.
Et vulgo faciunt id lutea, russaq; vela,
Et ferruginea, cum magnis intenta theatris
Per malos volgata, trabeisq; frementia flutunt.
Namq; ibi concessum caveai subter, & omnem
Scendi speciem patrum, matrumque, Deorumque,
Inficiunt, coguntq; suo fluitare Colore.
Ergo lintea de summo cum Corpore fucum
Mittunt, Effigias quoq; debent mittere tenueis
Res quæque, ex summo quoniam jaculantur utræq; &c. Lib.4.

Upon which Reason also the admirable *Kircher* hinted his parastatical Experiment, of Glossing the inside of a Chamber, and all things as well Furniture as Persons therein contained, with a pleasant disguise of grass Green, Azure, Crimson, or any other light Colour (for Black cannot consist in any Liquor, without so much density, as must terminate the Light:) only by disposing a capacious Vial of Glass, filled with the Tincture of Verdegrease, Lignum Nephriticum, or Vermilion, &c. in some aperture of the Window respecting the incident beams of the Sun. (*Art. Magn. Lucis, & Umbræ, lib.* 10. *part.*2. *Magiæ, parastaticæ Experimento* 5.)

Concerning

Concerning the SECOND, *viz.* the NATURE of Images Visible; we observe First, that *Epicurus* seems only to have revived and improved the notion of *Plato*, and *Empedocles*, who positively declared the sensible Forms, or Visible species of things, to be Ἀπορροίαι, *Effluxiones quædam substantiales:* in that He denominates them *Aporrhea*, and defines them to be most thin and only superficial Contextures of Atoms effluxed from the superficial parts of Bodies, and *jugi fluore*, by a continued stream emaning from them into all the circumfused space.

Art. 7. *Epicurus* opinion, of the *substantiality* of Images Visible, consonant to the judgment of *Plato* and *Empedocles*.

Secondly, that the Common Opinion, most pertinaciously patronized by *Alexander* the Peripatetick, and *Scaliger*, with the numerous herd of *Aristoteleans* (whom it is as easie to convert, as nominate) is, that visible species are *mera Accidentia*, simple pure Accidents, that neither possess, nor carry with them any thing of *Matter*, or Substance; and yet being transmitted through a diaphanous Medium from solid objects, they affect the organ of Sight, are reflected from polite and speculary bodies, &c. Here we are arrested with wonder, either how these great Masters of Learning could derive this wild conceit from their Oracle, *Aristotle*; when introth all they could ground upon his Authority of this kind, is desumable only from these words of his, *Colorem rei Visibilis movere perspicuum actu, quod deinceps oculum moveat:* or how they could judge it consentaneous to reason, that those Affections should be attributed to meer *Accidents*, which are manifestly Competent only to meer *Substances*. For, to be moved or to be the subject of Local Motion, to be impinged against, and reflected from, or permeate a body; to be dilated, contracted, inverted, &c. cannot consist, nor indeed by a sober man be conceived, without absolute *substantiality*. Some there are, we confess, who tell us, that they kindled this Conceit from sundry scattered sparks blended both in his general Discourses of Motion and Alteration, and particular Enquiries into the nature of Dreams, and Sounds, in his Problems: and these, thereupon, most confidently state the whole matter; thus. That the Visible Object doth first Generate a Consimilar Species in the parts of the aer next adjacent; that this Embryon species doth instantly Generate a second in the parts of the aer next to it, that generates a third, that third a fourth, and so they generate or spawn each other successively in all points of the Medium, untill the last species produced in the aer contiguous to the Horny membrane of the eye, doth therein produce another; which præsents to the Optick Nerve the exact delineations and pourtraiture of the Protoplast, or Object. To Cure the Schools of this Delirium, our advice is, that they first purge off that fæculent humor of Pædantism, and implicite adhærence to Authority; and then with clean stomachs take this effectual *Alterative:*

Art. 8. The *Aristoteleans* Thesis, that Images optical are meer *Accidents*, recited: and

If the *Visible Species* of Objects be, as they define; meer *Accidents*, i. e. *immaterial*: we Demand (1) What doth *Creat* them? Not the *Object*; since that hath neither power, nor art, nor instruments, to pourtray its own Counterfeit on the table of the contiguous aer. (2) What doth *Conserve* and *Support* them when pourtray'd? Not the *Aer*; since that is variously agitated, and dispelled by the wind, and commoved every way by Light pervading it: and yet the Species of objects are alwayes transmitted in a direct line to the eye. (3) What can *Transport* them? Neither *Aer*, nor *Light*: since it is of the formal reason of an *Accident*, not to be removed or transmitted but in the arms of it Subject. Nor can the same numerical

Art. 9. Convicted of Sundry *Impossibilities*, *Inconsistences*, and *Absurdities*.

species be extended through the whole space of the Medium; because it is repugnant to their supposition: and themselves affirm the transmigration of an Accident from one subject to another, impossible. (4) Is the species changed and multiplied by *Propagation*? That's if not an impossibility absolute, yet a Difficulty inexplicable; first because no man ever hath, nor can explain the *Modus Propagationis*, the manner of their Propagation: Secondly, since the parts of space intermediate betwixt the Object and the Eye, though but at a small distance removed, are innumerable; and a fresh propagation must be successively in each of those parts; and the space of Time required to each single propagation is a moment; certainly it must be long before the propagation could attain to so small a part of space, as is æqual to one Digit. If so; how many hours would run by, after the Suns Emergency out of an Eclipse, before the light of it would arrive at our eye? since, as the moments, or points of space betwixt it and us are more then innumerable; so likewise must the moments, or points of Time, while a fresh species is generated in each point of that vast space, be more then innumerable: and yet we have the Demonstration of the most Scientifick of our senses, that the light of the Sun is darted through that immense space, in one single moment. (5) What is the material of these species, or Whether is the Adam or First species educed out of *Nothing*? That's manifestly absurd; because above the power of Nature: and to recur to any other power superior to Hers, is downright madness. (6) Or, *ex Materiæ Potentia*, out of some secret Energie of the matter of the Medium? That's Unconceivable; for we dare the whole world to define, what kind of Power that is, supposed inhærent in the Medium (Aer, Water, Glass, or any other τὸ διαφανὲς) that can be actuated so expeditely into the production of infinite several species, in a moment. From one and the same part of Aer, in one and the same moment, how can be educed the different species not only of the Sun and a Stone, of a Man and a Stock, of a Head and a Foot; but even of two absolute Contraries, Snow and Pich? (7) If Visible Species contain nothing of Matter; how can they with such insuperable Velocity be projected on a speculary body, and recoyl back from it to so great a distance, as is commonly observed, even in the Repercussion, or rather Reflection of a Species from a Concave Glass: How consist of Various Parts, and conserve the order and position of them invariate, and the Colours of each clearly inconfused, through the interval of the Medium? How be really ampliated, contracted, deflected, inverted, &c. All which are properly and solely Congruent to Bodies or Entities consisting of Matter? (8) But all these and many more as manifest Incongruities and open Absurdities may be prævented by the assumption of the more durable and satisfactory Hypothesis of *Epicurus*: for conceding the Visible Species of Objects to be *Substantial Effluxes*, it can be no difficulty to solve their Trajection, Impaction, Refraction, Reflexion, Contraction, Diduction, Inversion, &c.

Art. 10. The grand *Objection* of *Alexander*, that a continual Effluxe of substance must minorate the Quantity of the most solid Visible.

Nor is it oppugnable by the objection of any *Difficulty* more considerable, then that so insultingly urged by *Alexander* the Peripatetick: *quanam ratione fieri possit, ut ex tot, tantisque effluentibus particulis, unumquodque adspectabilium non celeriter absumatur?* How can it consist with reason, since the Visible Species are præsumed to be substantial Effluviaes, that any the most solid and large adspectable body should not in a short time be minorated, nay wholly exhausted by the continual deperdition of so many

many particles? (*in Comment. in lib. de Sensu & Sensili, cap. 3. & Epist. 56. ad Dioscor.*)

Which yet is not so ponderous, as not to be counterpoysed by these two Reasons, (1) Ἀνιπτερσκεύεσθαι ὀυτοῖς ἄλλα, *Accrescere ipsis adspectabilibus advenientia ex opposito corpuscula alia*; that the decay is prævented by the apposition and accretion of other minute particles succeeding into the rooms of the effluxed; so that how much of substance decedes from the superficial parts of one body towards others, as much accedes to it by the advent of the like Emanations from others, and thereupon ensues a plenary Compensation. Nor can it diminish one grain of the weight of this solution, to rejoyn; that the Figures of adspectables must then be changed: because the substantial Effluxes which Accede, cannot be in point of Figure, Order, and Position of parts exactly consimilar to those which Recede. For, though there be a dissimilitude in Figure, betwixt the Deceding and Acceding particles; yet, in so great a tenuity of particles, as we suppose in our substantial species, that can produce no mutation of Figure in the object deprehensible by the sense: for many things remain invariate to the eye, which are yet very much changed as to Figure, in the judgment of the understanding; as may most eminently be exemplified in the Change that every Age insensibly stealeth upon the face of man. (2) λεπτομερέστατον εἶναι Ἀνυπερβολήν, *Tenuitatem simulachrorum esse omnem modum excedentem*, the Tenuity of these Emanant Images is Extreme; and therefore the uninterrupted Emission of them, even for many hundreds of years, can introduce no sensible either mutation of Figure; or minoration of Quantity in the superficies of the Emittent. Which *Averrhoes* (at least the Author of that Book, *Destructionis Destructionum*, fathered upon him) had respect unto, when He said; *Neminem agniturum decrementum in Sole factum, tametsi ab eo circum deperierit quantitas palmi, aut etiam major.*

Art. 11. Solved by two Reasons; the possible *Accretion* of other particles; and the extreme *Tenuity* of the Emanant.

To approach some degrees nearer in our Comprehension to the almost Incomprehensible TENUITY of these substantial Emanations, that essence the Visible Images of Objects; Let us First, conceive them, with *Lucretius*, to be, *Quasi Membranæ summo de Corpore rerum Dereptæ*, Certain *Excortications*, or a kind of most thin *Films*, by the subtle fingers of *Light*, stript off from the superficial Extremes of Bodies; for *Alexander* himself calls them ὑμενωδεῖς, καὶ φλοιωδεῖς, *Pelliculæ* & *Membranulæ*, & *Apuleius Exuviæ*. because as the *slough* or spoil of a Snake, is but a thin integument blancht off the new skin, and yet representing the various Spots, Scales, Magnitude, Figure &c. thereof: so likewise do the Visible Species, being meer *Decortications*, or *Sloughs* blancht off from Bodies, carry an exact resemblance of all Lineaments and Colours in the Exteriours thereof.

Art. 12. The *Tenuity* of Images visible, reduced to some degree of Comprehensibility, by conceiving them to be most thin *Decortications*.

Secondly, assume the smallest of things Visible, the Foot of an *Handworm*, for the Object. For conceding the species Emanant from it, which is deprehensible by a Microscope, to consist only of those Atoms, which cohæring only *Secundum Latera*, and *non* κατὰ βάθος, *Laterally* and not *Profoundly*, constitute the superficies: and then we cannot deny, that this species must be by many Myriads of Myriads of Atoms thinner then the Foot, or Object it self;

Art. 13. By *Instance*, in the Visible species of the *Foot* of a Handworm.

Thirdly,

Art. 14. By *Exemplifying* in the numerous round *Films* of Wax, successively derepted from a Wax tapour by the flame thereof, in the space of an hour: and

Thirdly, Exemplifie the ineffable Tenuity of these Excortications, in those round Films of Wax that are successively lickt off by the Flame of a Tapour accended. For, having supposed, that one inch of a Wax Candle may suffice to maintain its flame, for the space of an hour: let us thus reason. Since the Diminution of that inch, perpendicularly erected, is unceſſant, i. e. that there is no distinguishable moment of time, wherein there is not a distinct round of Wax taken off the upper part thereof, by the depredatory activity of the flame: how many must the Round Films of Wax be, that are successively derepted? Certainly, as many as there are distinguishable points, or parts in the 24 part of the Æquator, or ambite of the Primum Mobile, successively interjacent toward the Meridian. And if, in stead of that vast Heaven, the Primum Mobile, you think it more convenient to assume the Terrestrial Globe (whose Magnitude, in comparison of the other, amounts not above a point) observe what may be thence inferred. Since, according to the supputation of *Snellius* and *Gassendus*, the ambite of the Earth is commensurable by 26255 Italian miles; and the 24 part thereof makes 1094 miles, and so 1094000 paces, and so 5470000 feet, each whereof is again subdivisible into 1000 sensible parts: it follows, that as the product, or whole number of these parts in the 24 part of the Circumference of the Globe Terrestrial ariseth to 5470000000; so likewise must the distinct membranules of Wax successive derepted from the inch of Candle in the space of an hour fulfil the same high number of 5470000000. And if so, pray how incomprehensible thin must each of them be?

Art. 15. In the innumerable Films of Oyl, likewise successively delibrated, by the flame of an Ellychnium, or Match, perpendicularly floating in a vessel of equal capacity with *Solomons* Brazen Sea, in the space of 48 hours.

If this Example seem too gross to adumbrate the extreme Tenuity of our species; be pleased to exchange the Wax Tapour of an inch diameter, for *Solomons Brasen Sea*, filled with oyl, and an inch of Cotten Weeck perpendicularly immersed, and at the upper extreme accensed, in the middle thereof. For, insomuch as the Decrement of the oyl in altitude must be unceſſant, as is the exhausting activity of the flame, there being no instant of time, wherein its diminution is interrupted; and that, should the flame constantly adhære to the Weeck for 48 hours, without extinction, the space of the oyls descent from the margin of the vessel could not in crassitude equal that of a piece of Lawn, or a Spiders Web: certainly the number of Rounds of oyl successively delibrated by the flame, in that constitute time, must require a far greater number of Cyphers to its Calculation. Which would you definitely know; 'tis but computing the distinguishable points of time in 48 hours, during which the flame is supposed to live, and you have your desire; and we ours, as to the conjectural apprehension of the Tenuity of each of them.

Art. 16. By the Analogy betwixt an *Odorable* & *Visible* Species.

Lastly, let us argue *à simili*, and guess at the Tenuity of a Visible, from that of an *Odorable* Species. How many *Aromaticks* are there, that for many years together, emit fragrant exhalations, that replenish a considerable space of the ambient aer; and gratefully affect the nostrils of all persons, within the orb of projection: and yet cannot, upon the exactest statick experiment, or trutination of the Scate, be found to have amitted one grain of Quantity? Now if we consider, how Crass the Emanation of an Aromatick, or an odorous Anathymiasis, is comparatively to the substance of a Visible Species (for no meaner a Philosopher then *Gassendus*, whose name sounds all the Liberall Sciences, hath conceived; that the Visible Images effluxing from an Apple in a whole year, if all cast into one bulk, would not exceed

exceed that of the odorous vapour exhaled from it in one moment) we shall not gainsay, but a solid Body may constantly maintain an Emanation of its Images Visible, for many hundreds of years, from its superficial parts, without any sensible abatement of Quantity, or variation of Figure. To which we shall superadd only this; that should we allow these substantial Effluxes, that are supposed to constitute the Visible Species, to amount in many hundred years, to a mass deprehensible by sense, in case the collection of them all into one were possible: yet would it be so small, as to elude the exactest observation of man; for, who that hath perchance weighed a piece of Marble, or Gold, and set down the præcise gravity thereof in his life time, can obtain a parrol from the grave and return to complete his experiment; after the deflux of so many Ages, as are required to fulfill the sensibility of its minoration?

Art. 7. The Manner and Reason of the *Production* of visible Images; according to the hypothesis of *Epicurus*.

Concerning the THIRD, *viz.* the PRODUCTION of Species Visible; *Epicurus* Text may be fully illustrated by this Exposition. That a solid Body, so long as environed with a rare or permeable space, may be conceived without Alogie, freely to emit its Images: because it hath Atoms ready in the superfice, that being actuated by their coessential motive Faculty, unceſſantly attempt their Emancipation, or Abduction; and those so exile, that the Ambient cannot impede their Emanation. (2) That in regard they conserve the Delineations both of the Depressed and Eminent parts in the superfice of the Antitype, or Object, after their Efflux therefrom: therefore do the Images deceding from it become Configurate of Atoms cohærently exhaling in the same Order and Position that they held among themselves, during their Contiguity, or Adhæsion. Which also satisfies for the præsumed meer superficiality, i. e. *Improfundity* of the species: because it is deraded only from the Extremities of the Object. (3) That, forasmuch as no Cause can be alledged, why the particles of the Image should, in their progress through a pervious medium to considerable distance, be deturbed or discomposed from that Contexture, or order and situation, which they obtained from the Cortex or outward Film of their solid original: therefore do they invariately hold the same Configuration, untill their arrival at the eye. Which to familiarize, we are to reflect upon a position or two formerly conceded, viz. that Atoms are, by the impulse of their ingenite Motion, variously agitated even in Concretions most compact; and yet cannot without difficulty expede themselves from the Interior or Central parts, because of their mutual Revinction, or Complication: but for those in the Exterior or superficial parts, they may, upon the least evolution disingage themselves, having no Atoms without to depress, but many within to express or impel them. (4) That, since the Motion of all Atoms, when at liberty to pursue the Tendency of their Motive Faculty, is *Æquivelox:* hence is it, that those Atoms which exhale from the Cavities or Depreſt parts of the superficies of any Concretion, and those which exhale from the Prominencies, or Eminent Parts, are transferred together in that order, that they touch not, nor crowd each other, but observe the same distance and decorum, that they had in their Contiguity to, and immediate separation from the superficies. So that the Antecedent Atoms cannot be overtaken, or prævented by the Consequent: nor those farther outstrip these, then at the first start. (5) That the Emanation of Visible Images is *Continent*, i. e. that one succeeds on the heels of another, *jugi quodam Fluere*, in a continued stream more swiftly then that thought can distinguish any interme-

intermediate distance. So that, as in the Exsilition of Water from the Cock of a Cistern perpetually supplied by a Fountain, the parts thereof so closely succede each other, as to make one Continued stream, without any interruption observable: are we to conceive the Efflux of Images to be so Continent, that the Consequent press upon the neck of the Antecedent so contiguously, as the Eye can deprehend no Discontinuity, nor the Mind discern any Interstice in their Flux. And this ushers us to the reason, why *Apuleius*, discoursing in the Dialect of *Epicurus*, saith, *Profectas à nobis Imagines, velut quasdam exuvias jugi fluore manare.* (6) And lastly, that a Visible Image doth not so constantly retain its Figure, and Colours, as not to be subject to Mutilation and Confusion, if the interval betwixt its original and the eye be immoderately large: as may be exemplified in the species of a square Tower, which by a long trajection through the aer, hath its Angles retused, so that it enters the eye in a Cylindrical Figure. This *Epicurus* expresly admitted in his ἐνιότε συγχεομένων ὑπάρχειν, *confusam interdum evadere imaginem.* Which ought to be interpreted not only of the detriment sustained in its long progress through the Medium, but also of that which may arise from some perturbation caused in the superfice of the Exhalant.

Art. 18. The *Celerity* of the *Motion* of visible Images, reasoned; and compared to that of the *Light* of the Sun.

Concerning the FOURTH, *viz.* the CELERITY of their Motion; this will *Epicurus* have to be Ἀνυπέρβλητον, *Inexsuperabilem*, swift in the highest degree: and his Reason is, because such is the Pernicity of Atoms, when enfranchised from Concretions, and upon the Wings of their Gravity. *Lucretius* most appositely compares the Celerity of Images in their Trajection, to that of the beams of the Sun, which from the body thereof are darted to the superfice of the Earth in an instant, or so small a part of time, as none can be supposed less. And this we may clearly comprehend, if we observe that moment when the Sun begins its Emergency from the Discuss of the Moon, in an Eclipse; for in the same moment, we may discern the Image of its cleared limbus, appearing in a vessel of Water, respectively situate.

Art. 19. The Translation of a moveable from place to place, in an *indivisible point* of time, impossible: and why?

And yet we say, the Celerity of their Trajection, not, with the Vulgar, the *Instantaneous* Motion: because we conceive it impossible, that any *Moveable* should be transferred to a distant place, in an indivisible moment, but in some space of time, though so short as to be imperceptible; because the Medium hath parts so successively ranged, that the remote cannot be pervaded before the vicine.

Art. 20. The *Facility* of the *Abduction*, or *Avolation* of Images Visible, from solid Concretions; solved by the *Spontaneous Exsilition* of their superficial Atoms: and the *Sollicitation* of *Light*, incident upon them.

And thus have we concisely Commented upon the 4 *Considerables* comprehended in the Text of *Epicurus*, touching Apostatical Images Visible; and thereupon accumulated those Reasons, which justifie our prælation of this His Opinion, to that not only less probable, but manifestly impossible one of the *Aristoteleans*: so that there seems to us only one Consideration more requirable to complete its Verisimility, and that is touching the FACILITY of the ABDUCTION of Visible Images from solids.

We confess, that *Epicurus* supposition, of the spontaneous Evolution and consequent Avolation of Atoms from the extremes of solid Concretions; is not alone extensible to the solution of this Difficulty: and therefore we

we must lengthen it out with that consentaneous Position of *Gassendus* (*de apparente magnitudine solis humilis & sublimis*, *Epist.2. pag.* 24.) *Lucem sollicitare species*, that *Light* doth sollicite and more then excite the Visible species of Objects, as well by agitating the superficial Atoms of Concretions, as by Carrying them off in the arms of its reflected rayes. For, that Light is intinged not only with Colours, which it pervades, but also with those, which it only superficially toucheth upon, provided the Colorate body be compact enough to repercuss it; all opace and speculary bodies, on which its beams are either trajectly, or reflextly impinged, sensibly demonstrate. And though it may be objected, that the sollicitation of *Light* is not necessary to the Dereption, or Abduction of Images Visible; because it is generally præsumed, that they continually Emane from Objects, and so as well in the thickest Darkness, as in the Meridian light: it must notwithstanding be confest, that they are unprofitable to Vision, unless when they proceed from an object *Illustrate*; and consequently that they flow hand in hand with the particles of Light reflected from it superfice. Which truly is the reason why the Eye that is posited in the dark doth well discern Objects posited in the Light; but that which is in the light hath no perception at all of objects in the dark.

*Art.*21. That Objects do not emit their Visible Images, but when *Illustrated:* a Conceit though paradoxical, yet not improbable.

And therefore whoso shall affirme, that Visible Species are not Emitted from bodies, unless Light strike upon them, and being repercussed, carry their superficial Atoms, which constitute the Visible Species, off from them, in direct lines towards the eye: though He may perhaps want a Demonstration, yet not the evidence of Experience and probability, to credit his Paradox. Nor is there, why we should opinion, that only the Primary, or first incident Light is reflected; because Light emaneth from the Lucid, in a continued Fluor, so that the præcedent particles are still contiguously pursued by the consequent: and hence is it that Light is capable of repercussions even to infinity, if solid and impervious bodies could be so disposed, as that the first opposed might repercuss it on the second, the second reflect it to the third, the third to the fourth, &c. successively, so long as the Fluor should be continued, and no Eclipse intervene. For, the reason, why Light, formerly diffused, doth immediately disappear, upon the intervention of any body, that intersects it stream; is really the same with that, wherefore Water exsilient from the Tube of a Cistern, in an arched stream, doth immediately droop and fall perpendicularly, upon the shutting of the Cock: the successive flux of those parts of Water, which, by a close and forceable pressure on the back of the præcedent, maintained the Arcuation of the stream, being thereby prævented, and the effluxed committed to the tendency of their Gravity. And the reason, why by the mediation of a small remainder of light, after the intersection of its fluor from the Lucid fountain, we have an imperfect and obscure discernment of objects; is no more then this: that only a few rayes, here and there one, are incident upon and so reflected from the superfice thereof, having touched upon only a few scattered particles, and left the greater number untoucht; which therefore remain unperceived by the eye, because there wanted Light sufficient to the illustration of the whole, and so to the Excitement and Emission of a perfect species.

Sect. II.

Art. 1. Visible Images *Systatical*, described; and distinguisht from *Apostatical* ones.

THere is yet a *second* sort of Images Visible, which though consistent of the same *Materials* with the Former; are yet different in the reason of their production, according to the theory of *Epicurus*. For, as the former are perfectly substantial, being Corporeal Effluviaes, by a kind of Dereption as it were blancht from the Extremes of Concretions: so likewise are these of the second Genus, perfectly substantial, being certain Concrements or Coagmentations of Atoms in the aer, representing the shapes of Men, Beasts, Trees, Castles, Armies, &c. not caused by an immediate Dereption from such solid Prototypes, but a SPONTANEOUS convention and cohæsion of convenient particles. So that if we only call them, *Spontaneous Systatical Representations*; we shall not only import the Disparity of their Creation to that of the *Derepted Apostatical* ones, but also afford a glimpse of their abstruse *Nature*. Of these, all that can be brought to lye in lines parallel to our præsent Theorem, doth concern only their *Existence*: and that may be evicted by the conspiring testimonies of many Authors, whose pens were not dipt in the fading ink of meer Tradition, nor their minds deluded with the affectation of Fabulous Wonders. Among which our leasure will extend to the quotation of only *Two*, most pertinent and significant.

Art. 2. Their *Existence* assured, by the testimony of *Diodorus Siculus*: and

Diodorus Siculus (*lib.*3.) speaking of certain *Spectraes*; spontaneously conceited, and at set seasons of the year exhibiting themselves to Travellers in the regions of Africa, beyond the Quick-sands and Cyrene; saith thus: *πολὺ γὰρ τίνας καιρὸς, καὶ μάλιστα κατὰ τὰς νυκτερίας, συστάσεις ὁρῶνται κατὰ τὸν ἀέρα παντοίων ζώων ἰδέας ἐμφαίνουσαι; Quandoque, ac præsertim vigente tranquillitate aeris, conspiciuntur per aerem Concrementa quædam, formas Animalium omnis generis referentia. Ipsorum nonnulla quietè se habent, nonnulla verò motionem subeunt. Quinetiam interdum insequentes fugiant, interdum fugientes insequuntur, &c.*

Art. 3. *Damascius*, together with the Autopsy of *Kircher*.

And *Damascius* (*in Vita Isidori Philosophi, apud Photium*) declaring the common report about that memorable *τέρατον*, or *Prodious* Aereal Representation, annually beheld in the lower region of the aer, imminent upon that arm of the Adriatick Sea, that runs up betwixt Messana in Sicily, and Rhegium Julium in Calabria; delivers it thus: *Nostra tempestate narrarunt homines bonæ fidei, juxta Siciliam in campo nominato Tetrapyrgio, & in aliis non paucis locis, videri Equitum pugnantium simulacra; idq; maximè æstatis tempore, cum ardentissimus est meridies; &c.* Concerning the verity of this report, the most Curious *Athanasius Kircherus* having some doubt; purposely takes a long journey from Rome to Messana and thence crosseth over to Rhegium, at the opportune time for its observation. Where what He beheld, and by what Physical reasons he solved the wonderment; we have thought worthy your patient notice, to extract from his excellent discourse thereupon (*in cap.* 1. *Magiæ Parastaticæ, parastasi* 1. *Naturæ.*)

MORGANA

MORGANA RHEGINORUM.

Art. 4. *Kirchers* Description of that famous Apparition at Rhegium, called *Morgana Rheginorum*: &c.

In the midst of Summer, when the Sun boyls the Tyrrhene Ocean with most fervent rayes, then is it, that wanton Nature entertains the wondring eyes of the inhabitants of Rhegium, a Town in Calabria most ancient and no less famous for having been the seat of many Philosophers, with a prodigious spectacle in the aer. There may you, whether with more delight, or wonder, is not soon determined, behold a spacious Theatre in the vaporous aer, adorned with great variety of Scenes, and Catoptrick representations; the Images of Castles, Palaces, and other Buildings of excellent architecture, with sundry ranges of Pillars, præsented according to the rules of Perspective. This Scene withdrawn, upon the sayling by of the Cloud, there succeeds another, wherein, by way of exquisite Landskip, were exhibited spacious Woods, Groves of Cypress, Orchards with variety of trees, but those artificially planted in Uniform rows like a perfect Phalanx, large Meadows, with companies of men, and herds of beasts walking, feeding, and couching upon them: and all these with so great variety of respondent Colours, so admirable a commixture of Light and Darkness, and all their motions and gestures counterfeited so to the life, that to draw a Landskip of equal perfection seems impossible to human industry.

Art. 5. Most ingenious Investigation of the *Causes* thereof.

It may well be conceived, though not easily expreſt, how much this Parastatical Phantasm (which the Inhabitants of Rhegium call *Morgana*) hath excruciated the greatest Wits of *Italy*, while they laboured to explore a reason for the apparence of such things in the Cloud, as were not found either on the shore, or adjacent fields. This much encreased the ardor of Curiosity in me, so that crossing over from Messana to Rhegium, at the usual time of the Apparition, I examined all the Circumstances thereof, together with the situation of the place, the nature and propriety of the soyl, and the constitution of the vapours arising from the Sea: and examining my observations by Physical and Optical reasons, I soon detected the Causes of the whole Phænomenon. First I observed the Mountain called Tinna, on the Sicilian side, directly confronting Rhegium, to run along in a duskish obscure tract upon Pelorus; and the shores subjacent, as also the bottom of the Sea, to be covered with shining sand, being the fragments of *Selenites*, *Antimony*, and other *pellucid* Concretions, devolved from the eminent parts of the land, the contiguous Hills, that are richly fraught with veins of those Minerals. Then I observed that these translucid sands, being, together with vapors from the Sea and Shore, exhaled into the aer, by the intense fervor of the Sun; did coalesce into a Cloud, in all points respondent to a perfect Polyedrical, or Multangular Looking-glass: the various superficies of the resplendent Granules, making a multiplication of the species; and that these, being opacated behind by crass and impervious vapours, directly facing the Mountains, did make reflection of the various Images of objects respective to their various positions to the eye. The several Rows of Pillars in the aereal Scene are caused by one single Pillar, erected on the Shore; for being by a manifold reflection from the various superficies of the tralucent particles, opacated on the hinder part by dense Vapours, in the specular Meteor, it is multiplyed even to infinity. No otherwise then as one single Image, posited betwixt two polyedrical Looking-glasses, confront-

ingly disposed, is so often repercussed or reflected from superfice to superfice, that it exhibiteth to the eye almost an infinite multitude of Images exactly consimilar. Thus also doth one man standing on the shore, become a whole Army in the Cloud; one Beast, a whole Herd, and one Tree a thick-set Grove. As for the vanishing of this first Scene, and the succession of a second, adorned with the representations of Castles, and other magnificent structures; the Cause hereof is this: since the eye of the Spectator hath its sight variously terminated in the several speculary superficies of the Cloud, that is in perpetual motion according to the impulse of the Wind; it comes to pass, that according to the rules of the Angles of Incidence and Reflection, divers Species are beheld under the same constitute Angle, and as the speculary Vapour doth reflect them toward the eye, which divers species are projected from objects conveniently situate; and particularly from the Castle on the ascent towards Rhegium from the place of our prospect.

Some, perhaps, may judge our affirmation, of the Elevation of those shining Grains of Vitreous Minerals into the aer, by the meer attraction of the Sun; and the Coalition of them there with the Cloud of Vapours: to be too large a morsel, to be swallowed by any throat, but that Cormorant one of Credulity. If so, all we require of them, is only to consider; that Hairs, Straws, grains of Sand, fragments of Wood, and such like Festucous Bodies, are frequently found immured in Hailstones: which doubtless, are sufficient arguments, that those things were first elevated by the beams of the Sun, recoyling from the earth, into the middle region of the aer, and there coagmentated with the vapours condensed into a Cloud, and frozen in its descent.

Art. 6. His admirable *Artifice*, for the exhibition of the like aereal Representation, in Imitation of Nature.

Now this solution of the *Morgana*, acquires the more of Certitude and Auctority from hence; that in imitation of this Natural Prodigious Ostent, or Aereal Representation, *Kircher* invented a way of exhibiting an Artificial one, by the Fragments of Glass, Selenites, Antimony, &c. stewed in an iron trough, and vapours ascending from Water superaffused, and terminated by a black Curtain superextended. The full description of which Artifice, He hath made the Subject of his 2. *parastasis in Magia Parastat. cap.* 1.

CHAP.

CHAP. III.

CONCERNING THE MANNER and REASON OF VISION.

SECT. I.

AMong the many different Conceptions of Philosophers, both Ancient and Modern, touching the Manner and Reason of the Discernment of the Magnitude, Figure, &c. of Visible Objects by the Visive Faculty in the Eye; the most Considerable are these.

Art. 1. The Reason of Vision, according to the opinion of the *Stoicks.*

(1) The STOICKS affirmed, that certain Visory Rayes deradiated from the brain, through the slender perforations of the Optick Nerves, into the eye, and from thence in a continued fluor to the object; do, by a kind of Procusion, and Compression, dispose the whole Aer intermediate in a direct line, into a Cone, whose Point consisteth in the superfice of the Eye, and Base in the superfice of the Object. And that, as the Hand by the mediation of a staff, imposed on a body, doth, according to the degrees of resistence made thereby either directly, or laterally, deprehend the Tactile Qualities thereof, i.e. whether it be Hard, or Soft, Smooth or Rough, whether it be Clay, or Wood, Iron, or Stone, Cloth, or Leather, &c. So likewise doth the Eye, by the mediation of this Aereal staff, discern whether the Adspectable Object, on which the Basis of it resteth, be White or Black, Green or Red, Symetrical or Asymetrical in the Figure of its parts, and consequently Beautiful or Deformed.

(2) ARISTO-

Art. 2. Of *Aristotle.*

(2) ARISTOTLE, though his judgment never acquiesced in any one point, as to this particular, doth yet seem to have most constantly inclined to this; that the Colour of the Visible doth move the *Perspicuum actu*, i. e. that *Illustrate Nature* in the Aer, Water, or any other τὸ διαφανὲς, *Transparent* body; and that, by reason of its *Continuity* from the extremes of the Object to the Eye, doth move the Eye, and by the mediation thereof the *Internal Sensorium* or Visive Faculty, and so inform it of the visible Qualities thereof. So that, according to the Descant of those, who pretend to be his most faithful Interpreters, we may understand Him, to have imagined the *Colour* of the object to be as it were the *Hand*; the diaphanous *Medium*, as it were the *Staff*; and the *Eye* as it were the *Body* on which it is imposed and impreſt: *è diametro* opposite to the conceit of the *Stoicks*, who suppose the *Eye* to supply the place of the *Hand*; the *Aer* to analogize the *Staff*; and the *Object* to respond to the *Body* on which it is imposed and impreſt.

Art. 3. O. the *Pythagoreans.*

(3) The PYTHAGOREANS determined the reason of Vision on the Reflexion of the Visive Rayes, in a continued stream emitted from the internal Eye, to the visible, back again into the eye; or, more plainly, that the radious Emanations from the Eye, arriving at the superfice of the object, are thereby immediately Repercussed in an uninterrupted stream home again to the eye, in their return bringing along with them a perfect representation thereof, as to Colour, Figure and Magnitude.

Art. 4. Of *Empedocles.*

(4) EMPEDOCLES, though admitting (as we hinted in the next præceding Chapter) substantial Effluxes, from the Visible to the Organ of Sight; doth also assume the Emission of certain Igneous or Lucid Spirits from the Organ to the Object: supposing the Eye to be a kind of Glass Lantern, illustrate, and illustrating the Visible, by its own Light.

Art. 5. Of *Plato.*

(5) PLATO, though He likewise avouched the Emanation of Corporeal Effluviaes from the Object; doth not yet allow them to arrive quite home at the Eye: but will have them to be met half way by rayes of Light extramitted from the Eye: and that these two streams of External and Internal Light encountring with some Renitency reciprocal, do recoyl each from other, and the stream of Internal Light resilient back into the eye, doth communicate unto it that particular kind of Impression, which it received from the stream of Extradvenient Light, in the encounter; and so the Sentient Faculty comes to perceive the adspectable Form of the object, at which the Radius of Internal Light is levelled. This we judge to be sense of his words (*in Timæo, circa finem tertiæ partis*) *Simulachrorum, quæ vel in speculis oboriuntur, vel in perspicua, laviq; cernuntur superficie; facilis assecutio est. Nam ex utriusq; ignis, tam intimi, quam extra positi Communione, ejusq; rursus consensu, & congruentia, qui passim terso, laviq; corpori accommodatus est; necessariò hæc omnia oriuntur, quam ignis oculorum cum eo igne, qui est è conspecto effusus, circa læve nitidumq; Corpus sese confundit.*

Art. 6. O *Epicurus.*

(6) EPICURUS, tacitely subverting all these, foundeth the Reason of Vision, not in any Action of the intermediate Aer, as the *Stoicks* and *Aristotle*; nor in any Radious Emanation from the Eye to or toward the Object,

Object, as the *Pythagoreans*, *Empedocles*, and *Plato*: but, in the Derivation of a substantial Efflux from the Object to the Eye.

(7) And as for the opinion of the excellent *Monsieur Des Cartes*, which with a kind of pleasant violence, hath so ravisht the assent of most of the Students of Physiology, in the præsent Age, especially such as affect the accommodation of Mechanick Maxims to the sensible operations of Nature; that their minds abhor the embraces of any other: those, who have not heedfully perused his *Dioptricks*, may fully comprehend it in summary; thus. *Art. 7. Of Mons. Des Cartes.*

For *Sensation in Common*, He defines it to be a simple *Perception*, whereby a certain *Motion*, derived from a body conveniently objected, communicated, by Impression, to the small Fibres, or Capillary Filaments of a Nerve; and by those, in regard of their Continuity, transmitted to the Tribunal, or Judicatory Seat of the Soul, or Mind (which He supposeth to be the *Glandula Pinealis*, in the centre of the Brain) and there distinctly apprehended, or judged of. So that the Divers Motions impreſt upon the slender threads of any Nerve, are sufficient to the Causation of divers perceptions; or, that we may not eclipse his notion by the obscurity of our Expression, that the Impulse, or stroke given to the Nerve, doth, by reason of the Continuity of its parts, cause another Motion, in all points answerable to the first received by the External Organ, to be carried quite home to the Throne of the Mind, which instantly makes a respective judgment concerning the Nature of the Object, from whence that particular Motion was derived. In a word, that only by the Variety of Strokes given to the External Organ; thence to the filaments of the Nerve annexed thereto, thence to the Præsence Chamber of the Soul: we are informed of the particular Qualities, and Conditions of every Sensible; the variety of these sensory Motions being dependent on the variety of Qualities in the Object, and the variety of judgments dependent on the variety of Motions communicate.

And for the sense of *Seeing*, in *special*; He conceives it to be made, not by the mediation of Images, but of certain *Motions* (whereof the Images are composed) transmitted through the Eye and Optick Nerve to the Centrals of the Brain: præsuming the Visible Image of an Object to be only an exact representation of the motions thereby impressed upon the External Sensorium; and accordingly determining the Reason of the Minds actual Discernment of the Colour, Situation, Distance, Magnitude, and Figure of a Visible, by the Instruments of Sight, to be this. (1) The Light desilient from the adspectable Body, in a direct line, called by the Masters of the Opticks, the Axe of Vision, percusseth the diaphanous fluid Medium, the Æther, or most subtile substance (by Him assumed to extend in a Continuate Fluor through the Universe, and so to maintain an absolute Plenitude, and Continuity of Parts therein.) (2) The Æther thus percussed by the Illuminant, serving as a Medium betwixt the Object and the Eye; conveyeth the impression through the outward Membranes and Humors, destined to Refraction, to the Optick Nerve most delicately expansed into the *Retina Tunica*, beyond the Chrystalline. (3) The Motion thus impreſt on the outward Extreme of the Optick Nerve, runs along the body of it to the inward Extreme, determined in the substance of the Brain. (4) The Brain receiving the impression, immediately gives notice thereof to its Noble Tenent;

nent, the Soul; which by the Quality of the stroke judgeth of the Quality of the Striker, or Object. In some proportion like an Exquisite *Musitian*, who by the tone of the sound thereby created, doth judge what Cord in a Virginal was strook, what jack strook that string, and what force the jack was moved withall, whether great, mean, or small, slow or quick, equal or unequal, tense or lax, &c.

Art. 8. The ingenuity of *Des Cartes* Conceit, acknowledged: but the solidity indubitated

This you'l say, is a Conceit of singular Plausibility, invented by a Wit transcendently acute, adorned with the elegant dress of most proper and significant Termes, illustrate with apposite similes and prægnant Examples, and disposed into a Method most advantageous for persuasion; and we should betray our selves into the Censure of being exceedingly either stupid, or malicious, should we not say so too: but yet we dare not (so sacred is the interest of Truth) allow it to be more then singularly *Plausible*; since those Arguments, wherewith the sage *Digby* (*in the* 32. *chap. of His Treatise of Bodies*) hath long since impugned it, are so exceedingly præponderant, as to over-ballance it by more then many moments of Reason; nor could *Des Cartes* himself, were He now Unglorified, satisfie for his Non-Retractation of this Error; after his examination of their Validity, by any more hopeful Excuse, then this; that no other opinion could have been consistent to His Cardinal Scope of *Solving all the Operations of Sense by Mechanick Principles.*

Art. 9. The Opinion of *Epicurus*, more satisfactory, then any other: because more Rational, and less obnoxious to inexplicable Difficulties.

Now, of all these Opinions recited, we can find, after mature and æquitable examination, none that seems, either grounded on so much Reason, or attended with so few Difficulties, or so sufficient to the verisimilous Explanation of all the Problems, concerning the Manner of Vision, as that of *Epicurus*; which stateth the Reason of Vision in the INCURSION of substantial Images into the Eye. We say

FIRST, *Grounded on so much Reason.* For, insomuch as it is indisputable, that in the act of Vision there is a certain *Sigillation* of the figure and colour of the object, made upon that part of the Eye, wherein the Perception is; and this sigillation cannot be conceived to be effected otherwise then by an *Impression*; nor that Impression be conceived to be made, but by way of *Incursion* of the Image, or Type: it is a clear Consequence, that to admit a Sigillation without Impression, and an Impression without Incursion of the Image, is a manifest *Alogy*, an open Inconsistence. And upon this consideration is it, that we have judged *Epicurus* to have shot nearest the White, in his Position that Vision is performed, διὰ εἰδώλων ἐμπτώσεως, *per simulachrorum Incursionem, sive Incidentiam:* which *Agellius* (*lib.*5.*cap.*16.) descanting upon, saith expresly, *Epicurus affluere semper ex omnibus corporibus simulachra quædam ipsorum, eaque sese in oculos inferre, atque ita fieri sensum videndi putat.*

SECONDLY, *Encumbred with so few Difficulties.* For, of all that have been hitherto, either by *Alexander* (2. *de Anima* 34.) *Macrobius* (7.*Saturnal.*14.) *Galen* (*lib.*7. *de Consensu in Platonicis, Hippocraticisque Decretis*) or any other Author, whose leaves we have revolved, objected against it; we find only *Two*, that require a profound exercise of the Intellect to their Solution: and they are these.

(1) *Obvious*

(1) *Obvious it is even to sense, that every Species Visible is wholly in the whole space of the Medium, and wholly in every part thereof; since in what part soever of the Medium, the Eye shall be admoved, in a position convenient, it shall behold the whole object, represented by the species: and manifest it is, that to be total in the total Space, and total in every part thereof, is an Affection proper only to Incorporeals; therefore cannot Vision be made by Corporeal Images incurrent into the Eye.*

Art. 10. The *Two* most considerable *Difficulties* opposed to *Epicurus* position, of the Incursion of *Substantial* Images into the Eye.

(2) *In the intermediate Aer are coexistent the Images of many, nay innumerable Objects; which seems impossible, unless those Images are præsumed to be Incorporeal: because many Bodies cannot coexist in one and the same place, without reciprocal penetration of Dimensions, Ergo, &c.*

SECT. II.

TO dispel these Clouds, that have so long eclipsed the splendor of *Epicurus* Assertion, of the *Incidence* of Images Visible into the Eye (for we shall not here dispute, whether he intended the sigillation to be made in that *Convex Speculum*, the *Chrystalline Humour*; or that *Concave* one, the *Retina Tunica*) and explicate the abstruse nature of Vision: we ask leave to possess you with certain necessary *Propositions*: We assume therefore,

Assumption the First.

That the superfice of no Visible is so exquisitely smooth, polite, or equal, as not to contain various Inæqualities, i. e. Protuberant and Depress parts, or certain (Monticuli and Valleculæ) small Risings and Fallings: which in some bodies being either larger, or more, are discoverable by the naked intuition of the Eye; and in others, either smaller, or fewer, require the detection of the Microscope.

Art. 1. That the superfice of no body is *perfectly smooth*: evicted by solid *Reason*, and *Autopsie*.

This is neither Præcarious, nor Conjectural: but warranted by Reason, and autoptical Demonstration. For, if the object assumed be polisht *Marble*; since that apparent Tersness in the surface thereof is introduced by the detrition of its grosser inæqualities by Sand, and that Sand is nothing but a multitude of Polyedrical solid Grains, by the acuteness and hardness of their Angles cutting and derasing the more friable particles of the Marble: it must follow, that each of the grains of Sand must leave an impression of its edge, and so that the whole superfice must become scarified by innumerable small incisions, variously decussating and intersecting each other. If *Steel* of a speculary smoothness, such as our common Chalybeat Mirrours; since the Tersness thereof is artificial, caused by the affriction of Files, which cut only by the acuteness of their teeth, or lineal inæqualities: it is not easie to admit, that they leave no scratches, or exarations on the surface thereof; and where are many Incisions, each whereof must in Latitude respond to the thickness of the Tooth in the File, that made it, there also must

be as many Eminences or small Ridges intercepted among them. And if *Glass*, whose smoothness seems superlative; since it is composed of Sand and Salts, not so perfectly dissolved by liquation, as not to retain various Angles: it cannot be unreasonable to inferr, that those remaining points or angular parts must render the Composition in its exteriors full of Asperities. And, as for Autoptical Evidence; that Marble, Steel, and Glass are unequal in their superfice, is undeniable not only from hence, that a good Engyscope, in a convenient light, doth discover innumerable rugosities and Cavities in the most polisht superfice of either: but also from hence, that Spiders and Flyes do ordinarily run up and down perpendicularly on Venice Glass, which they could not do, if there were not in the surface thereof many small Cavities, or Fastnings for the reception of the Uncinulæ, or Hooks of their Feet. To which may also be added, the Humectation of Glass by any Liquor affused; for, if there were no Fosses and Prominences in the superfice thereof, whereon the Hamous particles of the Liquid might be fastned, it would instantly run off without leaving the least of moisture behind. And hence

Assumption the Second.

Art. 2. That the visible Image doth consist of so many Rayes as there are Points designable in the whole superfice of the object: and that each Ray hath its line of Tendency direct, respective to the face of that particle in the superfice, from which it is emitted.

That as the whole Visible Image doth emane from the whole superfice of the Object; so do all the parts thereof emane from all the parts of the Object: i.e. that look how many Atoms are designable in the superfice, from so many points thereof do Atoms exhale, which being contiguously pursued by others and others successively deceding, make continued Rayes, in direct lines tending thitherward, whither the faces of the particles point, from which they are deradiated.

For, insomuch as in the superfice no particle can be so minute to the sense, as, in respect to the Asperity, or Inæquality of its surface, not to have various Faces, by which to respect various parts of the Medium: it must inevitably follow, that all the rayes effluxed from an object, do not tend one and the same way, but are variously trajected through the Medium, some upward, others downward, some to the right, others to the left, some obversly or toward, others aversly or fromward, &c. So that there is no region or point of the compass designable, to which some rayes are not direct. And from this branch shoots forth our,

Third Assumption.

Art. 3. That the Density and *Union* of the Rayes, composing the visible Image, is greater or less; according to their less, or greater *Elongation* from the Object.

That every visible Image is then most Dense and United, when it is first abduced from the Object: or, *that by how much the neerer the visible Species is to the Body, from which it is delibrated, by so much the more Dense and United are the rayes of which it doth consist; and so much the more Rare or Disgregate, by how much the farther it is removed from it.* This may be exemplified in lines drawn from the Centre of a Circle to the Circumference; for by how much the farther they run from the Centre, by so much the greater space is intercepted betwixt them: and by how much the larger space is intercepted betwixt them, by so much the greater must their Rarity be, the degrees of Rarity being determinable by the degrees of intercepted space. Thus

Thus also must the rayes of the Visible Image, in their progress mutually recede each from other, and according to the more or less of their Elongation from the point of abduction, become more or less Rare and scattered, into the amplitude of the Medium. However, we deny not the necessity of their innumerable *Decussations*, and *Intersections*; in respect to the various Faces, and Confrontings of the parts of the superfice, from which they are emitted. And hence we extracted our

Fourth Assumption.

Art. 4. That the Visible Image is neither total in the total medium; nor total in every part thereof: but so *manifold* as are the parts of the medium from which the object is discerrable. Contrary to the *Aristoteleans.*

That the Visible Image, though really diffused through the space of the medium within the sphear of Projection; is notwithstanding neither total in the total space, nor total in every part thereof, as is supposed in the First Objection: but so Manifold, as there are parts of the Medium, from which the Object is adspectable.

Art. 5. PARADOX. That no man can see the same particle of an object, with both Eyes at once; nay, not with the same Eye, if the level of its Visive Axe be changed.

Here may we introduce a *Paradox*, which yet doth not want a considerable proportion of Verisimilitude to justifie the sobriety and acuteness of his Wit, that first started it; which is, *That of divers men, at the same time, speculating the same object, no one doth behold the same parts thereof, that are beheld by another:* nay more, *that no man can see the same parts of an Object, with both eyes at once*; nay more, *not the same parts with the same eye*, if he remove it never so little, because the level of the Visive Axe is varied. This may be verified by a single reflection on the Cause hereof, which is the Inequality, or Asperity of the superfice of Bodies, seemingly most polite: for, in respect of that, it is of necessity, that various Rayes, proceeding from the various parts thereof, variously convene in the parts of the Medium; and insomuch as each of those rayes doth represent that particle only, from which it was effused, and no other, in their concurse they cannot but represent other and other parts, according to the respective places or regions of the Medium, in which the Eye is posited, that receives them. However, we shall familiarize it by *Example.* Let two men at once behold a Third, one before, the other behind: and both may be said to behold the same man, but, truly, not the same parts of him; because the eyes of one are obverted to his Anterior, and those of the other to his Posterior parts. Take it yet one note higher. Let the Face of a man be the Object, on which though divers persons gaze at the same time, one on the right a second on the left side, a third confrontingly, a fourth and a fifth obliquely betwixt the other three; and all may be said to have an equal prospect of the face: yet can it not be asserted, that they do all see the same parts thereof, but each a particular part. Whence it may be inferred, that albeit we may allow them all to behold his Fore-head, Eyes, Nose, Cheeks, Mouth, &c. yet can we not allow them all to see the same parts of Forehead, Eyes, Nose, Cheeks, &c. because of their unequal situation, which Causeth that the whole species prodient from the face, doth not tend into the whole medium, but into various parts of it, respective to the various faces of the deradiant parts. Moreover, because this præsumed Inæquality is not competent only to the greater parts of the face, such as the Eyes, Nose, Mouth, Chin, &c. but as justly considerable in the very *Skin*, which hath no designable place; wherein are not many smaller and smaller Eminencies and Depressions, deprehensible (if not by the Opticks of the body, yet) by the acies of the

Mind: hence is, that having imagined the Eyes of the Five Spectators to move their visive Axes from part to part successively, and as slowly as the shadow of the Gnomon steals over the parts of a Dial, untill they have ranged over the whole face; we may comprehend the necessity, of the discovery of a fresh part by every new aime or levell of each eye, and the baulking of others; as if in Particles of devex Figure, no Particels can be detected a new, but as many of those formerly discerned must be lost, and as many, nay more remain concealed.

Art. 6. CONSECTARY. That the Medium is not possessed with one simple Image; but by an *Aggregate* of innumerable Images, deradiate from the same object: all which notwithstanding constitute but one entire Image.

And this Consideration smoothly ushers in two *Consectaries*

(1) That to say, *one simple species doth replenish the whole Medium*, is not, in the strict Dialect of Reason, so proper, as to say, *the Medium is possessed by an Aggeries, or Convention of innumerable species*: which being divers in respect to the divers parts of the Object, from which they were deradiated, must also be divers in their Existence, and Diffusion through the several parts of the Perspicuum. And yet must they be allowed to constitute but *one entire* species; and this in respect to their Emanation from one Object: because as the single parts of the species represent the single parts of the object, so doth the whole of the species represent the whole of the Object.

Art. 7. CONSECTARY 2. That Myriads of different Images, emanant from different objects, may be Coexistent in the Aer; without reciprocal *penetration* of *Dimensions*, or *Confusion* of particles: contrary to the *Peripateticks*.

(2) *That many, nay Myriads of different Species may be Coexistent in the Common Medium, the Aer; and yet no necessity of the Coexistence of many Bodies in one and the same place*; it being as justifiable to affirm, that they reciprocally penetrate each others dimensions, as that the Warp and Woof, or intersecting threads in a Cloth, do mutually penetrate each other: because the Aer is variously interspersed with Inanities, or small empty *Roads*, convenient to the inconfused transmission of all those swarms of Rayes, of which the species consist. Have you not frequently observed, when many Candles were burning together in the same room, how, according to the various interposition of opace bodies, various degrees of Shadows and Light have been diffused into the several quarters of the same? and can you give any better reason of those various Intersections and Decussations of the several Lights, then this; that the rayes of Light streaming from the diverse Flames, are directly and inconfusedly trajected through the several inane Receptaries of the Aer, respective to the position of each Candle, without reciprocal impediment; the rayes of one, that are projected to the right hand, in no wise impeding the passage of those of another, that are projected to the left, in the same sensible part of the Aer. Exactly so do the rayes of divers Species Visible, in their progress through the aer, pass on in direct and uninterrupted lines, without Confusion: and though they may seem to possess the same sensible part of the medium, yet will not reason allow them to possess the same Insensible particles thereof; in regard the distinct transmission of each clearly demonstrateth, that each possesseth a distinct place. Nor doth this their *Juxta-position*, or extreme Nearness necessitate their *Confusion*; since we daily observe that Water and Wine may be so Commixt in a Vial, as therein can be assigned no sensible part, wherein are not some parts of both Liquors: and yet most certain it is, that the particles of Wine possess not the same *Invisible Loculaments*, or Receptaries, that are replete with the particles of Water, but others absolutely distinct; because otherwise there would be as much of Water, or Wine alone, in the Vial, as there is of both Water and Wine, which in that Continent

tinent is impossible. And hereupon we Conclude, that to admit every distinct species to replenish the whole medium; is no less dangerous, then to admit, that each of two Liquors confused doth singly replenish the whole Capacity or the Continent: the parity of reasons justifying the *Parallelism.*

Assumption the Fifth.

That the visible Image, being trajected through the Pupil, and having suffered its ultimate refraction in that Convex Mirror, the Chrystalline Humor; is received and determined in that principal seat of Vision, (which holds no remote analogy to a Concave Mirror) *the Retina Tunica, or Expansion of the Optick Nerve in the bottom of the eye: and therein represents the Object from whence it was deradiated, in all particulars to the life, i.e. with the same Colour, Figure, and Situation of parts, which it really beareth*; provided the Distance be not excessive.

Art. 8. That the place of the visible Images ultimate *Reception*, and complete *Perception*; is the Concave of the *Retina Tunica.*

The *First part* of this eminent Proposition, that excellent Mathematician, *Christopher Scheinerus*, hath so evicted by Physical Reasons, Optical Demonstrations, and singular Experiments; as no truth can seem capable of greater illustration, and less opposition: and therefore the greatest right we can do our selves, or you, in this point, is to remit you to the observant lecture of his whole Third Book, *de Fundament. Opticis*; which we dare commend with this just Elogie, that it is the most Elaborate and Satisfying investigation of the Principal Seat of Vision, that ever the World was enriched with, and He who shall desire a more accomplisht Discourse on that (formerly) abstruse Theorem, must encounter the censure of being either scarce Ingenious enough to comprehend, or scarce Ingenuous enough to acknowledge the convincing Energy of the Arguments and Demonstrations therein alledged, for the confirmation of his Thesis, *Radij formaliter visorij nativam sedem esse tunicam retinam.*

And the other is sufficiently evincible even from hence; That *the Sight*, or (if you please) *the Interior Faculty doth alwayes judge of the adspectable form of an Object, according to the Condition of the Image emanant from it*, at least, *according as it is represented by the Image, at the impression thereof on the principal visory part.* Which is a position of Eminent Certitude. For, no other Cause can be assigned, why the Visive Faculty doth deprehend and pronounce an object to be of this, or that particular Colour: but only this, that the Image impreſt on the Net-work Coat doth represent it in that particular Colour, and no other. Why, when half of the Object is eclipsed, by some opace body interposed, the eye can speculate, nor the faculty judge of no more then the unobscured half: but only this, that the Image is mutilated, and so consisteth of onely those radii, that are emitted from the unobscured half, and consequently can inferr the similitude of no more.

Art. 9. That the *Faculty* forms a *judgment* of the Conditions of the Object, according to the representation thereof by the Image, at its impression on the principal part of Vision, the *Amphiblestreides.*

Why

Why an Object, of whatever Colour, appeareth Red, when speculated through Glass of that Tincture: but only because the Image, in its trajection through that Medium, being infected with redness, retains the same even to its sigillation on the Expansion of the Optick Nerve. Why the sight, in some cases, especially in that of immoderate distance, and when the object is beheld through a Reversing Glass, deprehends the object under a false figure: but because the Image represents it under that dissimilar figure, having either its angles retused, by reason of a too long trajection through the Medium, or the situation of its parts inverted, by decussation of its rayes in the Glass.

Consectary the First.

Art. 10. Consectary. That the Image is the Cause of Objects apparence of this or that determinate *Magnitude.*

Now, it being no less Evident, then Certain, that the Image is the sole cause of the Objects apparence under such or such a determinate Colour, and of this or that determinate Figure: it is of pure Consequence, that the Image must also be the Cause of the Objects appearance in this or that determinate *Magnitude*; especially since Figure is essenced in the Termination of Magnitude, according to *Euclid.*(*lib.*1.*def.*14.)*Figura est, quæ sub aliquo, vel aliquibus terminis comprehenditur.* For, why doth the object appear to be of great, small, or mean dimensions; if not because the Image arriving at the sentient, is great, small, or mean? Why doth the whole object appear greater then a part of it self; unless because the whole Image is greater then a part of it self? To speak more profoundly, and as men not altogether ignorant of the Mysteries in Opticks; demonstrable it is, that the Magnitude of a thing speculated may be commensurated by the proportion of the Image deradiated from it, to the distance of the Common Intersection. For as the Diametre of the Image, projected through a perspective, or Astronomical Tube, on a sheet of white paper, is in proportion to the Axis of the Pyramid Eversed; so is the diameter of the basis of the Object to the Axis of the Pyramid Direct. And hereby also come we to apprehend the *Distance* of the Object from the Eye; for having obtained the Latitude of the object, we cannot want the knowledge of its Distance: and by conversion, the knowledge of its distance both assists and facilitates the comprehension of its Magnitude. Which comes not much short of absolute necessity; since as *Des Cartes* (*Dioptrices cap.6.*) hath excellently observed, in these words: *Quoniam autem longitudo longius decurrentiam radiorum non exquisite salis ex modo impulsus cognosci potest, præcedens Distantiæ scientia hic in auxilium est vocanda. Sic, ex Gr. si distantia cognoscatur esse magna, & Angulus visionis sit parvus; res objecta longius distans judicatur magna: sin verò distantia sciatur esse parva, & angulus Visionis sit magnus; objectum judicatur esse parvum, si verò distantia objecti longius disiti sit in cognita; nihil certi de ejus magnitudine decerni potest:* if the Distance of an object far removed be unknown, the judgment concerning the magnitude thereof must be uncertain.

CONSECTARY the Second.

Art. 11. CONSECTARY 2. That no Image can repleniſh the Concave of the Retina Tunica, unleſs it be deradiated from an object of an almoſt *Hemiſpherical* ambite.

Again, inſomuch as the Receptary of the Viſible Image, is that Concave Mirrour, the Retina tunica (we call it a *Concave Mirrour*, not only in reſpect of its Figure and Uſe, but alſo in imitation of that grand Maſter of the Opticks, *Alhazen*, who (*in lib.* 1. *cap.* 2.) ſaith thus; *Et ſequitur ex hoc, at corpus ſentiens, quod eſt in Concavo Nervi* (*retina nimirum*) *ſit aliquantulùm Diaphanum, ut appareant in eo formæ lucis & coloris, &c.*) Hence is it, that no Image can totally fill that Receptary, unleſs it be derived from an object of an almoſt *Hemiſpherical* ambite, or Compaſs; ſo that the rayes, tending from it to the eye, may bear the form of a Cone, whoſe Baſe is the Hemiſphere, and point (ſomewhat retuſed) the ſuperfice of the Pupil. This perfectly accords to *Keplers* Canon; *Viſionem fieri, cum totius Hemiſpherij mundani, quod eſt ante oculum, & amplius paulò, idolum ſtatuitur ad album ſubrufum Retinæ cavæ ſuperficiei parietem.* (*in Paralipomen. ad Vitellion. cap.* 5. *de modo Viſion. num.* 1.) Not that either He, or we, by the Optical Hemiſphere, intend only the Arch of the Firmament; but any Ambite whatever, including a variety of things obverted to the open eye, partly directly, partly obliquely, or laterally, and Circumquaq; in all points about.

Art. 12. Why, when the Eye is open there is alwayes pourtrayed in the bottom thereof, ſome one *Total* Image; whoſe various Parts, are the *Special* Images of the ſeveral things included in the viſual Hemiſphere.

And this being conceded, we need not long hunt for a reaſon, why, when the eye is open, there alwayes is pourtraied in the bottom of the eye ſome one *Total Image*; whoſe various parts may be called the *Special Images* of the diverſe things at once objected. For, as the whole Hemiſphere Viſive includes the reaſon of the whole Viſible: ſo do the parts thereof include the reaſon of the ſpecial Viſibles, though ſituate at unequal diſtance. And, ſince, the Hemiſphere may be, in reſpect either of its whole, or parts, more Remote, and more Vicine; hence comes it, that no more Rayes arrive at the Eye from the Remote, than the Vicine: becauſe in the Vicine, indeed, are leſs or fewer bodies, than in the Remote, but yet the Particles, or Faces of the particles of bodies, that are directly obverted to the Pupil, are more. Which certainly is the Cauſe, why of two bodies, the one Great, the other Small, the Dimenſions ſeem equal; provided the Great be ſo remote, as to take up no greater a part of the Viſive Hemiſphere, than the ſmall: becauſe, in that caſe, the rayes emanant from it, and in direct lines incident into the pupill of the Eye, are no more then thoſe deradiate from the ſmall, and conſequently cannot repreſent more parts thereof, or exhibit it in larger Dimenſions. Whereupon we may conclude that the Viſive Faculty doth judge of the Magnitude of Objects, by the proportion that the Image of each holds to the amplitude of the Concave of the Retina Tunica: or, that by how much every ſpecial Image ſhall make a greater part of the General Image, that fills the whole Hemiſphere Viſive, and ſo poſſeſs a greater part of the Concave of the Retina Tunica; by ſo much the greater doth the Faculty judge the quantity thereof to be: and *è Contra.* And, becauſe a thing, when near, doth poſſeſs a greater part of the Viſive Hemiſphere, than when remote: therefore doth the ſpecial Image thereof alſo poſſeſs a greater part of the Concave in the Retina Tunica, and ſo exhibit in greater Dimenſions; and it decreaſeth, or becometh ſo much the leſs, by how much the farther it is abduced from the eye; For it then makes room for

for another Image of another thing, that is detected by the abduction of the former, and enters the space of the Hemisphere obverted. And hereupon may we ground a

PARADOX.

Art. 13. PARADOX. That the prospect of a *shilling* or object of a small diametre is as great, as the Prospect of the *Firmament.*

That the Eye sees no more at one prospect then at another: or, that the Eye beholds as much when it looks on a shilling, or any other object of as small diameter, as when it speculates a Mountain, nay the whole Heaven.

Which though obscure and despicable at first planting, will yet require no more time to grow up to a firm and spreading truth, than while we investigate the Reasons of Two Cozen-German optical *Phænomena's.*

(1) Why an Object appears not only greater in dimensions, but more distinct in parts, when lookt upon near at hand; than afarr off?

(2) Why an Object, speculated through a *Convex* Glass, appears both *larger* and more *distinct*; than when beheld only with eye: but through a *Concave*, both *Smaller*, and more *confused*?

Art. 14. Why an object appears both greater in Dimensions and more Distinct in parts, near at hand, than far off.

To the solution of the *First*, we are to reflect on some of the præcedent Assumptions. For, since every Visible diffuseth rayes from all points of it superfice, into all regions of the medium, according to the second *Assumption*; and since the superfice of the most seemingly smooth and polite body, is variously interspersed with Asperities, from the various faces whereof, innumerable rayes are emitted, tending according their lines of Direction, into all points of medium circularly; according to the first *Assumption*; and since those swarms of Emanations must be so much the more Dense and Congregate, by how much the less they are elongated from their fountain, or body exhalant; and *è Contra*, so much the more Rare and Disgregate, by how much farther they are deduced, according to the third *Assumption*: Therefore, by how much nearer the eye shall be to the object, by so much a greater number of Rayes shall it receive from the various parts thereof, and the particles of those parts; and *è Contra*: and Consequently by how much a greater number of rayes are received into the pupill of the eye, by so much greater do the dimensions of the object, and so much the more distinct do the parts of it superfice appear. For it is axiomatical among the Masters of the Opticks, and most perfectly demonstrated by *Scheinerus* (*in lib.* 2. *Fundament. Optic. part.*1. *cap.*13.) that the Visive Axe consisteth not of one single raye, but of many concurring in the point of the pyramid, terminated in the concave of the Retina Tunica: and as demonstrable, that those rayes only concurr in that conglomerated stream, which enters the Pupil, that are emitted from the parts of the object directly obverted unto it; all others tending into other quarters of the medium. And hence is it, that the image of a remote object, consisting of rayes (which though streaming from distant parts of the superfice thereof, do yet, by reason of their concurse in the retused point of the visive Pyramid, represent those parts as Conjoyned) thin and less united, comparatively; those parts must appear as Contiguous in the visifical Representation, or Image, which are really Incontiguous or seperate in the object: and upon consequence, the object must

must be apprehended as Contracted, or Less, as consisting of fewer parts; and also Confused, as consisting of parts not well distinguisht. This may be truly, though somewhat grosly, *Exemplified* in our prospect of two or three Hills situate at large distance from our eye, and all included in the same Visive Hemisphere; for, their Elongation from the Eye makes them appear Contiguous, nay one and the same Hill, though perhaps they are, by more then single miles, distant each from other: or, when from a place of eminence we behold a spacious Campania beneath, and apprehend it to be an intire Plane; the Non-apparence of those innumerable interjacent Fosses, Pits, Rivers, &c. depreſt places, imposing upon the sense, and exhibiting it in a smooth continued plane.

Art. 15. Why an object, speculated through a *Convex Lens*, appears both *greater* and more *distinct*; but through a *Concave*, *less* and more *Confused*: than when speculated only with the Eye.

And to the solution of the *second Problem*, a concise enquiry into the Causes of the different Effects of *Concave* and *Convex* Perspicils, in the representation of Images Visible, is only necessary. A Concave Lens, whether Plano-concave, or Concave on both sides, whether it be the segment of a great, or small Circle, projects the Image of an Object, on a paper set at convenient distance from the tube that holds it, Confused and insincere; because it refracts the rayes thereof even to Disgregation, so that never uniting again, they are transmitted in divided streams and cause a chaos, or perpetual confusion. On the Contrary, a Convex Lens refracts the rayes before divided, even to a Concurse and Union, and so makes that Image Distinct and Ordinate, which at its incidence thereon was confused and inordinate. And so much the more perfect must every Convex Lens be, by how much greater the Sphere is, of which it is a Section. For, as *Kircher* well observes (*in Magia parastatica.*) if the Lens be not only a portion of a great sphere, V. Gr. such a one, whose diametre contains twenty or thirty Roman Palms; but hath its own diametre consisting of one, or two palmes: it will represent objects of very large dimensions, with so admirable similitude, as to inform the Visive Faculty of all its Colours, Parts, and other discoverables in it superfice. Of which sort are those excellent Glasses, made by that famous Artist, *Eustachio Divini*, at Rome; by the help whereof the Painters of Italy use to draw the most exquisite Chorographical, Topographical, and Prosopographical Tables, in the World. This Difference betwixt Concave and Convex Perspicils is thus stated by *Kircher* (*Art. Magnæ Lucis & Umbræ lib.* 10. *Magiæ part.* 2. *Sect.* 5.) *Hinc patet differentia lentis Convexæ & Concavæ; quod illa confusam speciem acceptam transmissamque semper distinguit, & optimè ordinat: illa verò eandem perpetuò confundit; unde officium lentis Convexæ est, easdem confusè acceptas, in debita distantia, secundum suam potentiam, distinguere & ordinare.* And by *Scheinerus* (*in Fundam. Optic. lib.* 3. *part.* 1. *cap.* 11.) thus; *Licet in vitro quocunque refractio ad perpendicularem semper accidat, quia tamen ipsum superficie cava terminatur, radij in aerem egressi potius disperguntur, quàm colliguntur: cujus contrarium evenit vitro Convexo, ob contrariam extremitatem. Rationes sumuntur à Refractionibus in diversa tendentibus, vitri Convexi & Concavi, ob contrarias Extremitatum configurationes. Concavitas enim radios semper magis divergit: sicut Convexitas amplius colligit, &c.*

Now, to draw these lines home to the Centre of our problem; since the Rayes of a Visible Image trajected through a *Convex* Perspicil, are so refracted, as to concurr in the Visive Axe: it is a clear consequence, that therefore an object appears both larger in dimensions, and more distinct in parts, when speculated through a Convex Glass, than when lookt upon only with the Eye; because more of the rayes are, by reason of the Convexity of its extreme obverted to the object, conducted into the Pupil of the Eye, than otherwise would have been. For, whereas some rayes proceeding from those points of the object, which make the Centre of the Base of the Visive Pyramid, according to the line of Direction, incurr into the Pupil; others emanant from other parts circumvicine to those central ones, fall into the Iris; others from other parts circumvicine fall upon the eyelids; and others from others more remote, or nearer to the circumference of the Base of the Pyramid, strike upon the Eyebrows, Nose, Forehead, and other parts of the face: the Convexity of the Glass causeth, that all those rayes, which otherwise would have been terminated on the Iris, eyelids, brows, nose, forehead, &c. are Refracted, and by refraction deflected from the lines of Direction, so that concurring in the Visive Axe, they enter the Pupil of the Eye in one united stream, and so render the Image impreſt on the Retina Tunica, more lively and distinct, and encreased by so many parts, as are the rayes superadded to those, which proceed from the parts directly confronting the Pupil. On the Contrary; because an Image trajected through a *Concave* Perspicill, hath its rayes so refracted, that they become more rare and Disgregate: the object must therefore seem less in dimensions, and more confused in parts; because many of those rayes, which according to direct tendency would have insinuated into the Pupill, are diverted upon the Iris, Eyelids, and other circumvicine parts of the face.

Art. 16. DIGRESSION. What Figur'd *Perspicils* are convenient for *Old*: and what for *Purblind* persons.

Here opportunity enjoyns us to remember the duty of our Profession, nor would Charity dispense, should we, in this place, omit to prescribe some General Directions for the Melioration of sight, or natively, or accidentally imperfect. The most common Diminutions of Sight, and those that may best expect relief from Dioptrical Aphorisms, and the use of Glasses; are only Two: *Presbytia*, and *Myopia*. The *First*, as the word imports, being most familiar to old men, is (*Visus in perspiciendis objectis propinquis obscuritas; in remotis verò integrum acumen*) an imperfection of the sight, by reason whereof objects near hand appear obscure and confused, but at more distance, sufficiently clear and distinct. The Cause hereof generally, is the defect of due Convexity on the outside of the Chrystalline Humor; arising either from an Error of the Conformative Faculty in the Contexture of the parts of the Eye, or (and that mostly) from a Consumption of part of the Chrystalline Humour by that Marasmus, Old Age: which makes the common Base of the Image Visible to be trajected so far inwards, as not to be determined precisely in the Centre of the concave of the *Retina Tunica*. And therefore, according to the law of Contrariety, the Cure of this frequent symptome is chiefly, if not only to be hoped from the use of *Convex* Spectacles. which determine the point of Concurse exactly in the Centre of the Retina Tunica; the rayes, by reason of the double Convexity, viz. of the Lens and Chrystalline Humor, being sooner and more vigorously united, in the due place.

The *Other*, being Contrary to the first, and alwayes *Native*, commonly named

named *Purblindness*, Physitians define to be *Obscuritus visus in cernendis rebus distantibus; in propinquis verò integrum acumen:* a Dimness of the sight in the discernment of Objects, unless they be appropinquate to the Eye. The *Causes* hereof generally are either the too spherical Figure of the Chrystalline Humor; or, in the Ductus Ciliares, or small Filaments of the Aranea Tunica (the proper investment of the Chrystalline) a certain ineptitude to that contraction, requisite to the adduction of the Chrystalline inwards towards the retina tunica, which is necessary to the discernment of objects at distance: either of these Causes making the common Base of the Image to be determined in the Vitrious Humor, and consequently the Image to arrive at the retina tunica, perturbed and confused. And therefore our advice is to all Purblind Persons, that they use *Concave* Spectacles: for, such prolong the point of concurse, untill it be convenient, i. e. to the concave of the retina tunica.

Assumption the Sixth and last.

Since all objects speculated under the same Angle, seem of equal Magnitude (according to that of *Scheinerus, sicut oculus rem per se parvam, magnam arbitratur, quia sub magno angulo, refractionis beneficio, illam apprehendit: & magnam contrario parvam; fundament. Optic. lib. 2. part. 2. cap. 5.*) and are accordingly judged, unless there intervene an Opinion of their unequal Distance, which makes the Spectator præsume, that that Object is in it self the Greater, which is the more Remote, and that the Less, which is the less Remote: therefore, to the appehension and Dijudication of one of two objects, apparently equal, to be really the greater, is not required a greater Image, than to the apprehension and dijudication of an object to be really the less; but only an opinion of its greater Distance.

Art. 17. That to the Dijudication of one of two objects, apparently Equal, to be really the Greater; is not required a greater Image: but only an *Opinion* of its greater *Distance.*

This may receive both Illustration and Confirmation from this easie *Experiment.* Having placed horizontally, in a valley, a plane Looking Glass, of no more then one foot diametre; you may behold therein, at one intuition the Images of the firmament, of the invironing Hills, and all other things circumsituate, and those holding the same magnitude, as when speculated directly, and with the naked eye: and this only because, though the Image in Dimensions exceed not the Area of the Glass, yet is it such, as that together with the things seen, it doth also exhibit the Distance of each from other. Exactly like a good Landskip, wherein the ingenious Painter doth artificially delude the eye by a proportionate diminution and decurtation of the things præsented, insinuating an opinion of their Distance. And therefore, the Reason, why the Images of many things, as of spacious Fields, embroydered with rowes of Trees, numerous Herds of Cattle, Flocks of Sheep, &c. may at once be received into that narrow window, the Pupill of the eye, of a man standing on an Hill, Tower, or other eminent place, advantageous for prospect: is only this, that to the Speculation of the Hemisphere comprehending all those things, in that determinate magnitude, is required no greater an Image, than to the Speculation of an Hemisphere, whose diametre is commensurable

only by an inch. Since neither more rayes are derived from the one to the Pupil of the Eye, than from the other: nor to the judication of the one to be so much Greater than the other, is ought required, beside an Opinion that one is so much more Distant than the other. And this we conceive a sufficient Demonstration of the Verity of our last *Paradox*, viz. that the Eye sees as much, when it looks on a shilling, or other object of as small diametre; as when it looks on the greatest Ocean.

Here most opportunely occurs to our Consideration that notorious PROBLEM, *Quomodo objecti distantia deprehendatur ab oculo?* How the Distance of the Object from the eye is perceived in the act of Vision?

Art. 18. *Des Cartes* Opinion, concerning the Reason of the Sights apprehending the *Distance* of an object:

This would *Des Cartes* have solved (1) By the *various Figuration of the Eye*. Because in the Conspection of Objects remote, the Pupil of the Eye is expanded circularly, for the admission of more Rayes; and the Chrystalline Humor somewhat retracted toward the Retina Tunica, for the Determination of the point of Concurse in the same, which otherwise would be somewhat too remote: and on the contrary, in the conspection of objects vicine, the Pupil is contracted circularly, and the Chrystalline Lens protruded somewhat outwardly, for the contrary respects. (2) By the *Distinct*, or *Confused* representation of the object; as also the *Fortitude*, or *Imbecillity* of Light illustrating the same. Because things represented confusedly, or illustrated with a weak light alwayes appear Remote: and on the contrary, things præsented distinctly or illustrate with a strong light, seem vicine.

Art. 19. Unsatisfactory; and that for two Considerations.

But all this we conceive unsatisfactory. (1) Because, unless the variation of the Figure of the Eye were *Gradual*, respective to the several degrees of distance intercedent betwixt it and the object; it is impossible the sight should judge an object to be at this or that Determinate remotion: and that the variation of the Figure of the Eye is not Gradual respective to the degree of distance, is evident even from hence; that the Pupil of the Eye is as much Expanded, and the Lens of the Chrystalline Humor as much Retracted toward the Retina Tunica, in the conspection of an object situate at one miles distance, as of one at 2, 3, 4, or more miles; there being a certain Term of the Expansion of the one part, and Retraction of the other. (2) Because though Vision be Distinct, or Confused, both according to the more or less illustration of the object by light, and to the greater or less Distance thereof from the Eye; yet doth this Reason hold only in mean, not large distance: since the orbs of the Sun and Moon appear greater at their rising immediately above the Horizon, that is, when they are more Remote from the Eye, than when they are in the Zenith of their gyre, that is, when they are more Vicine to the Eye; and since all objects illustrate with a weak light, do not appear Remote, nor *è contra*, as common observation demonstrateth.

Art. 20. And that more solid one of *Gassendus* (viz. *that the Cause of our apprehending the Distance of an object, consisteth in the Comparation of the several things interjacent betwixt the object and the Eye, by the Rational Faculty*) embraced and corroborated.

And therefore allowing the Acuteness of *Des Cartes* Conceit, we think it more safe, because more reasonable to acquiesce in the judgment of the grave *Gassendus*; who (*in Epist. 2. de Apparente Magnitud. solis humilis & sublimis*) most profoundly solves the Problem, by desuming the Cause of our apprehending the distance of an Object, in the act of Vision, from

from a *Comparison of the thing interjacent between the object seen, and the Eye.* For, though that *Comparation* be an act of the *Superior Faculty*; yet is the connexion thereof to the sense, necessary to the making a right judgment, concerning the Distance of the Visible. And, most certainly, therefore do two things at distance seem to be Continued, because they strike the Eye with cohærent, or contiguous Rayes. Thus doth the top of a Tower, though situate some miles beyond a Hill, yet seem Contiguous to the same, nay to the visible Horizon; and this only because it is speculated by the Mediation of Contiguous Rayes: and the Sun and Moon, both orient and occident, seem to cohære to the Horizon because though the spaces are immense, that intercede betwixt their Orbs and the Horizon, yet from those spaces doth not so much as one single Raye arrive at the Eye, and those which come to it from the Sun and Moon are contiguous to those which come from the Horizon. And hence is it, that the Tower, Hill, and Horizon seem to the sight to be equidistant from the Eye; because no other things are interposed, at least, seen interposed, by the comparison of which, the one may be deprehended more than the other. Besides, the distance of the Horizon it selfis not apprehended by any other reason, but the diversity of things interjacent betwixt it and the Eye: for, look how much of Space is possessed valleys and lower grounds interjacent, so much of Space is defalcated from the distance; the sight apprehending all those things to be Contiguous, or Continued, whose Rayes are received into the Eye, as Contiguous, or Continued, none of the spaces interjacent affording one raye. Of which truth *Des Cartes* seems to have had a glimpse, when (*in Dioptrices cap. 6. Sect.* 15.) he conceds; *objectorum, quæ intuemur, præcedaneam cognitionem, ipsorum distantiæ melius dignoscendæ inservire:* that a certain præcognition of the object doth much conduce to the more certain dignotion of its Distance.

Art. 21. PARADOX. That the same Object, speculated by the same man, at the same distance, and in the same degree of light; doth alwayes appear greater to one Eye, than the other

And on this branch may we ingraft a PARADOX; *that one and the same object, speculated by the same man, in the same degree of light, doth alwayes appear greater to one Eye, than to the other.* The truth of this is evincible by the joint testimony of those incorruptible Witnesses of Certitude, Experience and Reason. (1) Of *Experience*; because no man can make the vision of both his eyes equally perfect; but beholding a thing first with one eye, the other being closed, or eclipsed, and then with the other, the former being closed or eclipsed; shall constantly discover it to be greater in dimensions in the apprehension of one Eye, than of the other: and *Gassendus*, making a perfect and strict Experiment hereof, testifies of himself, (*in Epist.* 2. *de Apparent. Magnitud. Solis, &c. Sect.* 17.) that the Characters of his Book appeared to his right Eye, by a fifth part, greater in dimensions, though somewhat more obscure, than to his left. (2) Of *Reason*; because of all *Twin Parts* in the body, as Ears, Hands, Leggs, Testicles, &c. one is alwayes more vigorous and perfect, in the performance of its action, than the other. Which Inæquality of Vigour, if it be not the Bastard of Custom, may rightfully be Fathered upon either this; that one part is invigorated with a more liberal *afflux* of *Spirits*, than the other: or this, that the *Organical Constitution* of one Part is more perfect and firm, than that of the other. And, therefore, one Eye having its Pupill wider; or the figure of the Chrystalline more Convex, or the Retina Tunica more concave, than the other; must apprehend an object to be either larger in Dimensions, or more Distinct in Parts, than the other, whose parts are of a different configuration:

guration: either of these Causes necessitating a respective Disparity in the Action.

Art. 22. A second PARADOX. That all men see (distinctly) but with one Eye at once: contrary to that eminent Optical Axiom, *that the Visive Axes of both eyes concurr and unite in the object.*

If this sound strange in the ears of any man, how will he startle at the mention of that much more Paradoxical Thesis of *Joh. Baptista Porta* (*lib. 6. de Refraction. cap.* 1.) *That no man can see* (distinctly) *but with one eye at once?* Which though seemingly repugnant not only to common persuasion, but also to that high and mighty Axiom of *Alhazen, Vitellio, Franc. Bacon. Niceron*, and other the most eminent Professors of the Optiques, *That the Visive Axes of both eyes concurr and unite in the object speculated:* is yet a verity, well worthy our admission, and assertion. For, the Axes of the Eyes are so ordained by Nature, that when one is intended, the other is relaxed, when one is imployed, the other is idle and unconcerned; nor can they be both intended at once, or imployed, though both may be at once relaxed, or unimployed: as is Experimented, when with both eyes open we look on the leaf of a Book; for we then perceive the lines and print thereof, but do not *distinctly* discern the Characters, so as to read one word, till we fix the Axe of one eye thereon; and at that instant we feel a certain suddain subsultation, or gentle impulse in the Centre of that eye, arising doubtless from the rushing in of more spirits through the Optick Nerve, for the more efficacious performance of its action. The *Cause* of the impossibility of the intention of both Visive Axes at one object, may be desumed from the *Parallelism* of the *Motion* of the Eyes; which being most evident to sense, gives us just ground to admire, how so many subtle Mathematicians, and exquisite Oculists have not discovered the Coition and Union of the Visive Axes in the object speculated, which they so confidently build upon, to be an absolute Impossibility. For, though man hath two Eyes; yet doth he use but one at once, in the case of *Distinct* inspection, the right eye to discern objects on the right side, and the left to view objects on the left: nor is there more necessity, why he should use both Eyes at once, than both Arms, or Leggs, or Testicles, at once. And for an *Experiment* to assist this Reason; we shall desire you only to look at the top of your own Nose, and you shall soon be convicted, that you cannot discern it with both eyes at once; but the right side with the right eye, and afterward the left side with the left eye: and at the instant of changing the Axe of the first eye, you shall be sensible of that impulse of Spirits, newly mentioned. Nor, indeed, is it possible, that while your right eye is levelled at the right side of your nose, your left should be levelled at the left side, but on the contrary averted quite from it: because, the motion of the eyes being *Conjugate*, or *Parallel*, when the Axe of the right eye is converted to the right side of the nose, the Axe of the left must be converted toward the left Ear. And, therefore, since the Visive Axes of both Eyes cannot Concurr and Unite in the Tipp of the Nose; what can remain to persuade, that they must Concurr and unite in the same Letter, or Word in a book, which is not many inches more remote than the Nose? And, that you may satisfie your self, that the Visive Axes doe never meet, but run on in a perpetual Parallelism, i. e. in direct lines, as far distant each from other, as are the Eyes themselves; having fixed a staff or launce upright in the ground, and retreated from it to the distance of 10 or 20 paces, more or less: look as earnestly as you can, on it, with your right eye, closing your left, and you shall perceive it to eclipse a certain part of the wall, tree, or other body situate beyond it. Then look on it again with your left eye, closing your right; and you shall

shall observe it to eclipse another part of the wall: that space being intercepted, which is called the Parallaxe. This done, look on it with both eyes open; and if the Axes of both did meet and unite in the staff, as is generally supposed, then of necessity would you observe the staff to eclipse either both parts of the Wall together, or the middle of the Parallaxe: but you shall observe it to do neither, for the middle shall never be eclipsed; but only one of the parts, and that on which you shall fix one of your eyes more intently than the other. This considered, we dare second *Gassendus* in his promise to Gunners, that they shall shoot as right with both eyes open, as only with one: for levelling the mouth of the Peece directly at the mark, with one eye, their other must be wholly unconcerned therein, nor is it ought but the tyrannie of Custome, that can make it difficult.

Art. 23. The three Degrees of Vision, *viz. most perfect, perfect*, and *imperfect*: and the verity of the Paradox restrained only to the *two former* Degrees.

Here, to prevent the most formidable *Exception*, that lyes against this Paradox, we are to advertise you of two Considerables. *First*, that as well Philosophers, as Oculists unanimously admit three *Degrees*, or gradual Differences of sight. (1) *Visus Perfectissimus*, when we see the smallest (visible) particles of an object, most distinctly: (2) *Perfectus*, when we see an object distinctly enough, in the whole or parts, but apprehend not the particles, or minima visibilia thereof: (3) *Imperfectus*, when besides the object directly obverted to the Pupil of the eye, we also have a glimmering and imperfect perception of other things placed *ad latera*, on the right and left side of it. *Secondly*, that the verity of this Paradox, that we see but with one eye at once, is restrained only to the *First* and *Second* degrees of Sight, and extends not to the *Last*. For, Experience assures, that, as many things circumvicine to the principal object, on which we look only with one eye open, præsent themselves together with it, in a confused and obscure manner: so likewise, when both eyes are open, many things, obliquely incident into each eye, are confusedly, and indistinctly apprehended. So that in confused and Imperfect Vision, it may be truly said, that a man doth see with both eyes at once: but not in Distinct and Perfect.

SECT. III.

Art. 1. A research into the Reason of the different Effects of *Convex* and *Concave* Glasses; as well *Dioptrical*, as *Catoptrical*.

TO entertain Curiosity with a second Course, we shall here attempt the Conjectural Solution of those so much admired Effects of *Convex* and *Concave* Glasses; that is, Why the Rayes of Light, and together with them those substantial Effluxes, that essence the Visible Images of Objects, being trajected through a Convex Glass, or reflected from a Concave, are *Congregated* into a perpendicular stream: and likewise, why the Rayes of Light, being trajected through a Concave, or reflexed from a Convex, are *Disgregated* from a perpendicular radius.

First, insomuch as Glass, of the most polite and equal superfice is full of insensible *Pores*, or Perforations, and solid impervious *Granules*, alternately interspersed; we may upon consequence conceive, that each of those solid Granules is as it were a certain *Monticle*, or small Hillock, having a small top, and small sides circularly declining toward those little Valleys, the Pores. This

This conceded; if a Glass, whose superfice is *Plane*, be obverted to the Sun, since the small Pores thereof tend from one superfice to the other in direct and parallel lines, for the most part; it must be, that all the Rayes incident into the Pores, pass through in direct and parallel lines, into the Aer beyond it: and so can be neither Congregated, nor Disgregated, but must constantly pursue the same direct course, which they continued from the body of the Sun, to their incidence on the surface of the Glass. But if the Extream of the Glass, respecting the Sun, be of a *Convex* figure; then, because one Pore (conceive it to be the Central one) is directly obverted to the Sun, and all the others have their apertures more oblique and, pointing another way; therefore it comes to pass, that one ray, falling into the directly obverted pore, is directly trajected through the same, and passeth on into the aer beyond it in a direct line; but another ray, falling on the side of the Hillock next adjacent to the right pore, is thereby Refracted and Deflected, so that it progresseth not forward in a line parallel to the directly trajected ray, but being conjoined to it, passeth on in an united stream with it. And necessary it is, that the Angle of its Refraction be by so much the more *obtuse*, by how much nearer the point of the Hillock, from which it was refracted, is to the direct or perpendicularly transmitted ray; and, on the contrary, by so much the more *Acute*, by how much the more remote: because *There* the ray falls more deeply into the obvious pore, and strikes lower on the adjacent Hillock, whose Protuberancy therefore doth less Deflect it; but *Here* the ray falls higher on the side of the Hillock, and so by the Protuberancie, or Devexity thereof is more deflected. But if the Extreme of the Glass confronting the Sun, be of a *Concave* figure; in that case, because one pore being directly open, others have their apertures more obliquely respecting the Sun, it comes to pass, that the ray falling into the direct pore, is directly trajected, and passeth through the aer in a perpendicular; but another ray falling on the side of the next adjacent Hillock, is thereby refracted and deflected, so that it doth not continue its progress in a line parallel to the directly-transient ray, but is abduced from it, and that so much the more, by how much the farther it passeth beyond the Glass. And necessary it is, that the Angle of its Refraction be also so much the more obtuse, by how much nearer the point of its incidence on the side of the Hillock, is to the Aperture of the Direct pore; because it falls deeper into it, and strikes lower on the devex side of the Hillock: and on the contrary, so much the more Acute, by how much more remote its point of incidence is to the Aperture of the Direct pore; for the contrary respect. And this is the summ of our Conjecture, touching the reasons of the different Trajection of Rayes through Convex and Concave Glasses.

As for the other part of our Conception, concerning *Reflexed* Rayes; if the Glass obverted to the Sun be *Plane* in it superfice, then, because all the Topps of the solid and impervious *Hillocks*, are directly obverted to the Sun, therefore must it be, that all the rayes incident upon them become *Reflected* back again toward the Sun, if not in the same, yet at least in Contiguous lines. But if the face of the Glass obverted to the Sun, be *Convex*; then, because the topp of one Hillock is directly obverted, and those of others obliquely respecting the Sun; it comes to pass, that one ray being directly Reflected, the others are reflected obliquely in lines quite different: and this in an Angle by so much more Acute, by how much

nearer

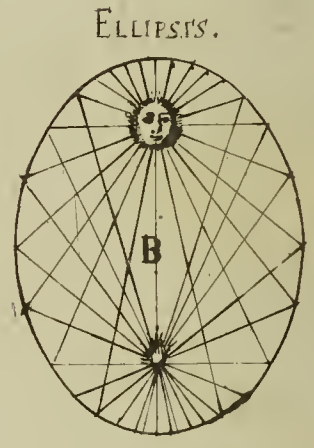
nearer the Topps of the obliquely respecting Hillocks are to that of the directly respecting one; and by so much the more obtuse, by how much the more Remote. And, if the side of the Glass turned toward the Sun, be *Concave*; because the Top, of one Hillock is directly, and those of others obliquely obverted to the Sun; hence comes it, that the Ray incident on the directly-obverted one, is directly Reflected, and those that fall on the topps of the obliquely-obverted ones, are accordingly reflected obliquely, toward the Directly reflected; so that at a certain distance they all Concurr and Unite with it in that point, called the *Term of Concurse*: and this in an Angle so much more Acute, by how much nearer the Topps of the obliquely-reflecting Hillocks are to that of the Directly-reflecting one; and *è contra*.

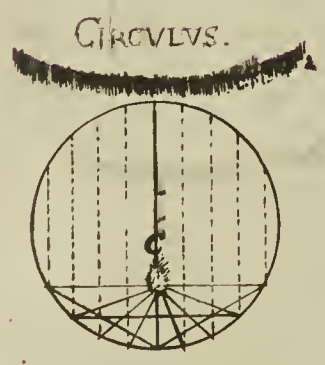
Figur. pag. 169.

Art. 2. A COROLLARIE. Hinting the Causes, why an *Elliptical* Concave reflects the incident rayes, in a more Acute angle, than a *Parabolical*: and a Parabolical than a *Spherical*.

These things clearly understood, we need not want a perfect Demonstration of the Causes, why a Concave Glass, whose Concavity consisteth of the segment of an *Ellipsis*, reflecteth the rayes of the Sun in a more *Acute* Angle, and consequently burneth both most vigorously, and at greater Distance, then one whose Concavity is the segment of a *Parabola*: and why a Parabolical Section reflecteth them in an Angle more *Acute*, and so burneth both at greater distance, and more vigorously, than the Section of *Circle*. Especally if we familiarize this theory by the accommodation of these *Figures*.

Figur. pag. 190.





Thus

Art. 36. A CONSECTARY. Why a *Plane* Perspicil exhibits an object in *genuine* Dimensions; but a *Convex*, in *Amplified*, and a *Concave*, in *minorated*.

Thus have we, in a short Discourse, not exceeding the narrow limits of a single Article, intelligibly explicated the Cause of that so much admired Disparity in the Effects of *Plane*, *Convex*, and *Concave*, Glasses; as well *Dioptrical*, or Trajecting the rayes of Light into the Aer beyond them, as *Catoptrical*, or Reflecting them back again from their obverted superfice. And we ask leave to encrease our Digression only with this CONSECTARY. Because the Rayes of Light, and the rayes of visible Images are Analogical in their nature, and flow hand in hand together into the Eye, in the act of Vision; therefore is it, that to a man using a *Plane Perspicil*, an object alwayes appears the *same*, i. e. equal in dimensions, and distinction of parts, as it doth to his naked Eye: by reason the Angle of its Extreams is the same in the Plane Glass, as in the Eye. But, to a man using a *Convex Perspicil*, an object appears *Greater*; because the Angle of its Extreams is amplified: and through a *Concave*, *Less*; because the Angle is diminished. In like manner, the Image of an object *reflected* from a *Plane Mirrour*, appears the *same* to the Spectator, as if Deradiated immediately, or without reflexion, from the object it self; because the Reflex Angle is equal to the Direct: but the Image of an Object Reflected from a *Convex Mirrour* appears *Less*; because the Angle of its Reflection is less than that of its Direction: and from a *Concave*, *Greater*; because the Reflex Angle is greater than the Direct: This may be autoptically Demonstrated thus. If you admit the Image of a man, or any thing else, through a small perforation of the wall, into an obscure chamber, and fix a Convex Lens in the perforation, with the Convex side toward the Light; you shall, admoving your eye thereto, at Convenient distance, observe the transmitted Image to be *Amplified*: but, receiving the Image on a sheet of white Paper, posited where your Eye was, you shall perceive it to be *Minorated*: the Contrary Effect arising from a *Concave Lens*, posited in the hole, with its Concave side toward the Light. And this, because the Convex Congregating the rayes into the Pupill of the Eye (and so making the φάσις, or Apparition Greater, for the cause formerly exposited) doth also Congregate them on the Paper; and therefore the Image cannot but appear Contracted, or Minorated: but on the contrary, the Concave Disgregating the rayes from the Pupil (and so making the φάσις, or Apparition less in the Retina of the Optick Nerve) doth also Disgregate, or diffuse them largely on all parts of the Paper, and so the Image thereon received cannot but appear much Amplified.

SECT. IV.

Art. 1. A Recapitulation of the principal Arguments precedent: and summary of the subsequent.

HItherto we have in some degree of satisfaction, explicated the Manner, how, by the Incursion of substantial Images, deradiated from the object to the Eye, the Visive Faculty comes to apprehend the *Colour*, *Figure*, *Magnitude*, *Number*, and *Distance* of objects: and therefore it remains only, to the Complement of our present Designation, that we explore the Reasons of the Perception of the *Situation*, *Quiet*, and *Motion* of objects, by the sight. To our more perspicuous solution of which notable Difficulty; and to the illustration of many passages precedent in the two last Sections: it must be confest not only ornamental, or advantageous, but simply necessary, that we here Anatomize the whole Eye, and consider the proper Uses of the several parts thereof; those especially, that are either immediately and primarily instrumental, or only secundarily inservient to Vision.

Art. 2. The Eye Anatomized: and the proper *use* of each Part thereof, either absolutely *Necessary*, or only *Advantagious* to Vision, concisely demonstrated. *viz.* of

1. The *Diaphanity* of the Horny Membrane, and the three Humors, *Aqueous*, *Chrystalline*, and *Vitreous*.

2. The *Convexity* of all its parts, except the *Amphiblestroides*.

Figur. pag. 173

In the Conformation of the Eye, or minor Microcosm, as *Casserius Placentinus* calls it, in respect to the admirable Constructure thereof; the *First* observable is, that it is composed of many *Diaphanous*, or Transparent Parts, as the *Horny Membrane* (B C B) the *Aqueous Humour* (E F K F E) the *Chrystalline* (L) and the *Vitreous* (M G H M I N): and the intention of that Unimitable Mistress of the Optiques, Nature, herein was, that the Visive Rayes might not be Reflected from, but easily *Trajected* through them, into the Amphiblestroides, or Net-work Coat, The *Second* is it *Convex Figure*; wherein the Providence of Nature had respect to the necessary Congregation and Unition of most of the rayes incident on the Area of the Eye, so that the Visive Axe might consist of many more rayes, than otherwise, i.e. had the figure of the Eye been Plane, or Concave, it would have done: for, being by this Convexity refracted, they convene in a Cone determined in the Centre of the *Amphiblestroides*. For the Convexity is so exactly proportionate to the Distance of the Retina Tunica from the Chrystalline, that most of the Visive Rayes, emanant from the several points of the object, and incident upon the several points of the Horny Membrane, may, after various Refractions, have their Rendezvouz, or point of Concurse exactly in the middle of the Retina Tunica: because, should their point of Concurse

curse be either short of, or beyond the Retina Tunica; of necessity the Image could not be at all, or, at most, but very obscurely presented therein, as consisting of Dispersed, and mutually Intersecting rayes. The *Third* is the *Uvea Tunica*, or anterior part of the *Choroides*, whose exterior superfice (E F, F E) being Diversicolor, or of various Colours, is called the *Iris* or Rainbow: which *Galen*, *Casserius Placentinus*, and *Riolanus* will have to consist of a six-fold Circle, but *Plempius* only of a Three-fold, the Two outmost at the white of the Eye being more narrow in latitude, and the Third respecting the Pupil of the Eye more ample, and illustrate with the constant colour on the Limbus of the *Uvea Tunica*, which in some bears Sables, in others Azure, in others Sables and Argent confused: whence the Difference of *Black*, *Blewish*, and *Grey Eyes*. In the middle of this Coat is a Perforation, called the Pupil, (F K F) and by the vulgar, the *Apple* of the eye; of such a Constitution, that by Dilatation and Constriction, as if it were a Sphinctre Muscle, it might be made wider, or narrower: and this for the Moderation of the incurrent rayes, which being sometimes more, sometimes fewer, and sometimes strong, sometimes weak, require a certain Moderation proportionate to the Faculty of the recipient and terminating sensory. For, insomuch as an excess of Light is destructive, and the Defect of it insufficient to distinct Vision; therefore did the Eternal Wisdome in the Entrance into the Chrystalline, contrive this Window capable of Dilatation and Constriction: in Dilatation to admit so much of the weaker Light as is required to perfect and distinct Vision; in Contraction to exclude so much of the Excessive, as would offend, if not perish the Organ. Yet in many the Amplitude of the Pupil varies, and those who have it very narrow, are strong and acute sighted; but those, who have it more dilated constantly, see but weakly and obtusely. The interior superfice of this Membrane is obduced, or lined with a certain *Fuliginous* substance that gives it the Colour of a blackish Grape, fully ripe: but to what end Nature provided this opacating Tincture, hath been a quæstion, that, even from *Galens* dayes to ours, hath made the Schools both of Anatomists and Professors of the Optiques, ring again with Controversies. Some affirming the design of Nature therein to be, that the Chrystalline being veyled over with this obscure parget, might have its own splendor more intense by Congregation: because, according to the position of *Alhazen* (*lib.* 1. *propos.* 33.) as a small light in a dark obscure place is better perceptible, as diffusing a brighter lustre, than in a wide, luminous place; and consequently makes the circumjacent parts more visible: so doth the internal splendour of the Chrystalline become more illustrious, because the inner circumference of the whole Uvea Tunica is lined with this sooty matter, the rayes deradiating from it by reflection from the opposite opacity of the Membrane, becoming reassembled and united in a more vigorous lustre. *Others* conceiving the intention of it to be, the Recreation or Refection of the Visive Spirits; because when ever the Chrystalline is offended, or rather the Amphiblestroides, with too vehement a Light, we use, for present remedy, to close our eyes, and the spirits recoyling upon the Chrystalline from the natural darkness of this Coat, are reassembled, and so refreshed. And *others* contesting that the only use of it is, the Interception of Light; for, since the Pupil, or anterior perforation of the Uvea Tunica, is the only Aperture, or portal framed for the intromission of the Visible Images, and there ought to be no other passage, whereat Light might intrude it self into the concave of the Eye: what could

3. The *Uvea Tunica*, and *Iris*.

4. The *Pupilla*.

5. The *Blackness* of the inside of the *Uvea Tunica*.

wise

wise Nature have thought on more convenient to the Exclusion of unnecessary light, than the interjection of this sable Curtain? Experience evincing that nothing intercepts and shuts out Light, than opace Bodies interposed. These, indeed, are ingenious and plausible Conceits, but if truth be to be preferred to Acuteness; we may determine, that the only and proper use of this Atramentous or sooty Blackness is, that the Rayes of Light, incident on the Concave of the Amphiblestroides, (G H I) and thence resilient back to the Concave of the Uvea Tunica, might by the Blackness of its lining be extinguisht, i. e. absolutely terminated: lest thence again Reflected to the Amphiblestroides, they might perturb the Visible Image, and consequently the sight. The *Fourth* observable, is the *Tunica Arachnoides*, in its middle containing the most pretious of Gemms, the *Chrystalline* Humor, whose Figure also is Convex (but whether of a Parabolical, Elliptical, or Sphærical Section, is a noble problem, because not yet determined.) on both sides, though somewhat more on that side respecting the Retina Tunica, and manifestly oblong, or inclining to an oval. This Coat, by the Mediation of the *Ciliary Processes*, or slender Filaments (B N, N B) dispersed from the Tunica Arachnoides, doth move the Chrystalline either nearer to, or farther from the Retina Tunica, as the greater or less Distance of the object requires. For, in the Chrystalline, by reason of its greater both Density and Convexity, the rays of the species are more strongly Refracted and more closely United, than in any other part of the Eye: which justifieth their opinion who make it the Primary Medium of Vision. Because, as a Convex Lens posited in a hole of the wall, admits the species into an obscure room and also collect the rayes of it: so doth the Chrystalline both admit and congregate them. And because it is Diaphanous, therefore are not the species terminated therein, as *Galen*, and after him most *Anatomists* have dreamt: since otherwise no reason can be alledged, why the species should not be as well terminated in the Horny Membrane, the Vitreous, or Aqueous Humour. Wherefore, Vision is not made in the Chrystalline but the Retina Tunica: because the species are therein Terminated, as in an opace body. *Scheinerus* opinioned, that the species, which otherwise, by reason of several refractions before their arrival at the Chrystalline, would have been exhibited in *Reverse* positions, are therein refracted, and Rectified. But, from the Observation of *Franc. Sylvius*, *Franc. Vander Schagen*, *Joh. Wallæus*, and *Athanas Kircherus*, the *tunica Choroides* being sublated from the hinder part of the Eye, and then the *Sclirotica*, and lastly the *Amphiblestroides*; all objects appear inversed in the Chrystalline: and in a smaller form by much in the Eye of an Oxe, than in the Eye of a Man. The same hath *Plempius* demonstrated by the Experiment of an Artificial Glass Eye, placed in the small Aperture of a Window: all things externally objected appearing therein Inverst, as also on a sheet of paper posited before the decussation of the rayes. And, doubtless, it is necessary, that the species be inverted, at their termination on the Retina Tunica; since otherwise we should have apprehended the object as inverst: which *Kepler* demonstrates from hence, that (*in passione Patientia Agentibus è regione esse opposita debere*) in Passion the Patients must be on the contrary region to the Agents. Some, we confess would have it, that the *judicatory Faculty* doth correct the depraved Figure of the species: because (forsooth) it discerns the just magnitude of objects and their situation, by most small Images; as a good Geometrician doth judge of the dimensions of *Hercules* whole body, by commensurating those of his Heel. And others consign that

6. The Tunica *Arachnoides.*

7. The *Ciliary Filaments* thereof

8. The *Chrystalline.*

9. The *Retina Tunica.*

that office to the *Common Sense*, which looking (*retrò & desuper*) on the inverted species, apprehends them in a right position. And lastly, others desume the right judgment, from the *rectitude* of the *line*, by which the species are impreſt. And thus poor man aggravates the Difficulties in Nature, though to his own greater disquiet and perplexity. The *Last* of Parts in the Eye, immediately necessary to Vision, is the *Retina Tunica*, or Net-work Coat (G H I) in the bottom of the Eye; contexed of an innumerable multitude of Filaments, or thread-like Expansions of the Optick Nerve: and this is that noble sensory, formed for the Last Reception and Sigillation of the Image, which from hence by the Continuity of the Optick Nerve, is communicated τῇ Ἡγεμονικῇ, to the *Principal Faculty*, residing in the Brain.

10. The six *Muscles*; viz.

But, because the Axe of the Visive Pyramid is a perpendicular line, beginning in the Extrems of the object, and ending in the Amphiblestroides; had the Eye been nailed or fixt in its orbita, we must have been necessitated to traverse the whole Machine of the body, for a position thereof convenient to Vision, since it can distinctly apprehend no object, but what lyes *è directo* opposite; or have had this semi-rational sense, whose glory builds on Variety, restrained to the speculation of so few things, that we should have received more Discomfort from their Paucity, than either Information, or Delight from their Discernment: therefore, that we might enjoy a more enlarged Prospect, and read the whole Hemisphere over in one momentany act of Vision, Nature hath furnished the Eyes with *Muscles*, or Organs of agility; that so they may accommodate themselves to every visible, and hold a voluntary verlisity to the intended object;

Parvula sic magnum pervisit Pupula Cœlum.

1. The *Direct*, as the

And of these *Ocular Muscles* there are in Man, just so many, as there are kinds of Motion, 4 *Direct*, and 2 *Oblique* or Circular; all situate within the Orbita, and associated to the Optick Nerve, and conjoining their Tendons, at the Horny Membrane, they constitute the *Tunica Innomitata*, so named by *Columbus*, who arrogates the invention thereof to himself, though *Galen* (*lib. 10. de usu part. cap. 2.*) makes express mention of it.

Atollent,

The *First* of the four *Direct* Muscles, implanted in the superiour part of the Eye, draweth it *Upward*; whence it is denominated *Atollens*, the Lifter up, and *Superbus*, the Proud: because this is that we use in Haughty and sublime looks.

Depriment,

The *Second*, situate in the inferiour part of the Eye, and Antagonist to the former, stoops the Eye Downward; and thence is called *Deprimens*, the Depressor, and *Humilis*, the Humble: for this position of the eye speaks the Dejection, and Humility of the Mind.

Adducent,

The *Third*, fastned in the Major Canthus, or great angle of the Eye, and converting it toward the Nose; is therefore named *Adducens*, the Adducent, and *Bibitorius*, for in large draughts we frequently contract it.

The

The *Fourth*, opposite both in situation and office to the former, abduceth the Eye laterally toward the Ear; and is therefore named *Abducens*, and *Indignatorius*, the scorning muscle: for, when we would cast a glance of scorn, contempt, or indignation, we contract the Eye towards the outward angle, by the help of this muscle. *Abducent.*

If all these Four work together, the Eye is retracted inward, fixt, and immote: which kind of Motion Physitians call *Motus Tonicus*, and in our language, the *Sett*, or *Wist* Look.

Of the *Oblique* Muscles, the *First*, running betwixt the Eye, and the tendons of the Second and Third Muscles, by the outward angle ascends to the superior part of the Eye, and inserted near to the Rainbow, circumgyrates the Eye downward. 2. And *Oblique*, as the 2 *Circumactors*, or Lovers Muscles.

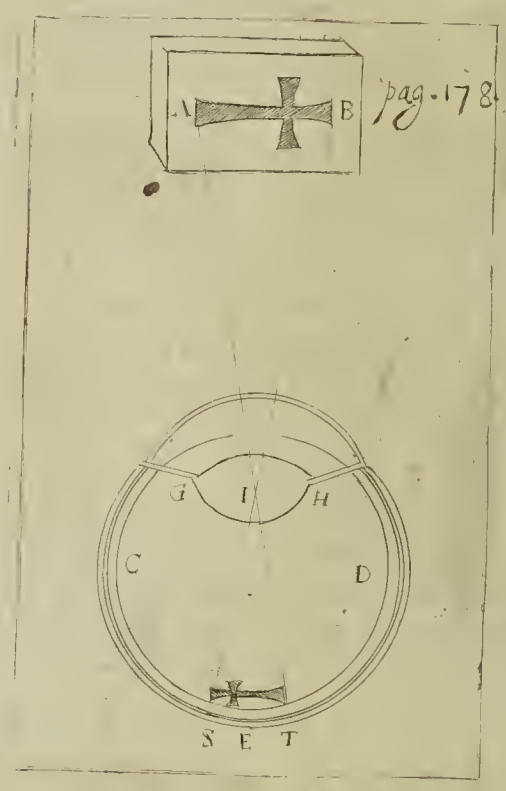
The *Second*, and smallest, twisted into a long tendon, circumrotates the Eye toward the interior angle, and is called the *Trochlea*, or Pully. These two Circumactors are sirnamed *Amatorij*, the Lovers Muscles; for these are they that roul about the eye in wanton or amorous Glances.

And thus much of the Conformation of the Eye.

Now, as to the Solution of our Problem, *viz.* How the SITUATION of an object is perceived by the sight? Since it is an indisputable Canon, *Omnem sensum deprehendere rem ad eam regionem, è qua ultimò directa motione feritur*, that every sense doth apprehend its proper object to be situate in that part of Space, from whence, by direct motion, it was thereby affected: we may safely inferr, that the Visible Object alwayes appears situate in that part of space, from whence the Image thereof in a direct line invadeth the Eye, and enters the Pupil thereof. Which is true and manifest not only in the intuition of an object by immediate or *Direct* rayes; but also in the inspection of Looking-Glasses, that represent the object by *Reflex*: and a pure Consequence, that a Visible Object, by impression of its rayes proceeding from a certain place, or region, must of necessity be perceived by the sight, in its genuine position, or *Erect* Form; though we have the testimony both of Reason and Autopsie, that the Image of every Visible is pourtraid in the Amphiblestroides, in an unnatural position, or *Everse* Form. *Art.* 3. Why the *Situation* of an object is perceived by the sight.

Art. 4. The Reason of the *Eversion* of the Image, in the *Amphiblestroides.*

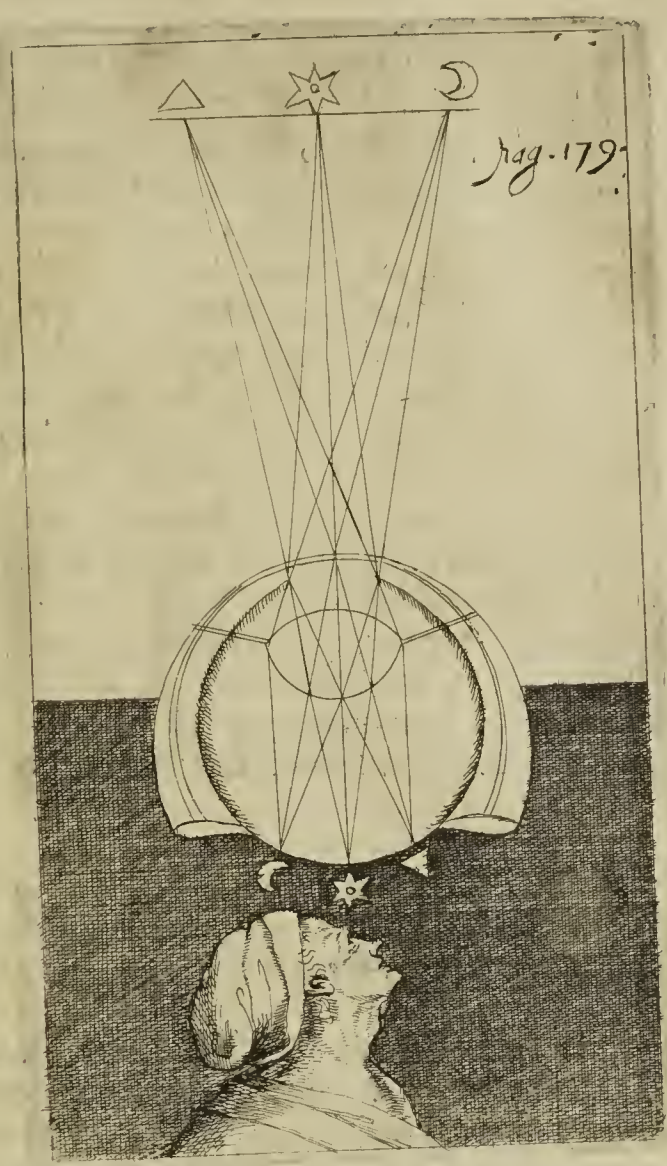
As for that of *Reason*, it is thus Demonstrated. Suppose the Eye to be C D; the bottome thereof to be E; the object illustrate by the Sun A B. *viz.* a Cross painted on a Wall; the Pupil of the Eye, G H; and the Centre of the Pupill, I; Now, the Image of this Cross emanant therefrom, and entering the Pupill, in the lines A T, B S, must arrive at the bottome of the Eye, S T, in an Everse, or præposterous Form: because the narrowness of the Pupil, together with the prævious Refraction, makes the rayes concurrent at the point I, to Decussate, or mutually intersect each other; so that the raye proceeding from A, falls upon the part of the Retina Tunica, T, and the ray B falls upon S. Which makes it of absolute necessity, that the upper part or Head of the Cross, A, be depicted in the lower patt of the Concave of the Retina Tunica, T: and the lower part, or Foot, B, in the upper part of the Concave of the Retina Tunica, S.



Art. 5. The same illustrate by an *Experiment.*

And, as for that of *Autopsie*, or Ocular Experiment; Take the Eye of an Oxe, or (if the Anatomick Theatre be open) of a man, for in that the species are represented more to the life, than in the Eye of any other Animal, as *Des Cartes* (*in dioptrices cap.* 5. *Sect.* 11.) and having gently stript off the three Coats in the bottome, in that part directly behind the Chrystalline, so that the Pellucidity thereof become visible, place it in a hole of proportionate magnitude, in the wall of your Closet, made obscure by excluding all other light, so that the Anterior part theaeof may respect the light. This done, admoving your Eye towards the denudated part of the Chrystalline; you may behold the Species of any thing obverted to the outside of the Eye, to enter through the Chrystalline to the bottom thereof, and there represented in a most lively figure, as if pourtrayed by the exquisite Pencil of *Apelles*; but whoily Eversed: as in this following *Iconisme.*

Finally,



Finally, an object appears either in *Motion*, or *Quiet*, according as the Image thereof, represented on the Retina Tunica, is moved: or Quiet: only because, according to the Canon, in the præsent Article, touching the reason of the perception of the situation of an object, the Visible is alwayes judged to be in that part of Space, from which, in a direct line, the last impression is made upon the *Sensorium*.

Art. 6. Why the *Motion* and *Quiet* of objects are discerned by the sight.

And this Reason is of extent sufficient to include the full Solution also of that PROBLEM, by *Alexander* (2. *de Anima* 34.) so insulting proposed to the Defendants of *Epicurus* Material Actinobolisme Visive, or the Emanation of substantial Images from the Object to the Eye: *viz. Why doth the Image of a man move, when reflected from a Mirrour, according as the man moves?* For, this Phænomenon we are to referr to the Variation of the parts of the Mirrour, from each of which it is necessary that a fresh Reflexion of the Species be made into the Eye: and consequently, that the Image appear moved,

Art. 7. Why *Catoptrical* Images imitate the motions of their *Antitypes* or Originals.

ved, according to the various motions of the object. The neceſſity of this is evident from hence; if you ſtand beholding your face in a Glaſs, and there be divers others ſtanding by, one at your right hand, another at your left, a third looking over your head in the ſame Glaſs; they ſhall all behold your image, but each in a diſtinct part of the Glaſs. Whence you may alſo underſtand, that in the Looking-glaſs is not only that Image, which you behold, but alſo innumerable others; and thoſe ſo mutually communicant, that in the ſame place, where you behold your noſe, another ſhall ſee your chin, a third your forehead, a fourth your mouth, a fifth your Eyes, &c. and yet doth no one ſee other then a ſimple and diſtinct Image. Moreover you may hence inferr, that in the medium is no point of Space, in which there is not formed a perfect Image of the rayes concurring therein, and advenient from the ſame object; though not from the ſame parts, or particles thereof: and conſequently that in the whole Medium there are no two Images perfectly alike; as alſo, that what the Vulgar Philoſophers teach, that the whole Image is in the whole Space or Medium, and whole in every part thereof, is a manifeſt Falſity. For, though it may be ſaid juſtly enough, that the whole Image, i. e. the *Aggregate* of all the Images, is in the whole Space: yet is there no part of that Space, in which the whole Image can be.

Art. 8. Why the *right* ſide of a Catoptrical Image reſpects the *Left* of its Exemplar. And why two Catoptrick Glaſſes, confrontingly poſited, cauſe a *Reſtitution* of the parts of the Image to the natural Form.

To this place belongs alſo that PROBLEM; *Why doth not the right hand of the Image reſpond to the right of the object: but contrariwiſe, the left to the right, and right to the left?*

The *Cauſe* whereof conſiſteth onely in the Images *Confronting* the Object: or, as *Plato* (*in Timæo*) moſt perſpicuouſly expreſſeth it, *quia contrarijs viſus partibus ad contrarias partes fit contactus.* Underſtand it by ſuppoſing a ſecond perſon poſited in the place of the Mirrour, and confronting the firſt: for, his right hand muſt be oppoſed to the others left.

Nor is the reaſon of the Inverſion of the parts of the Image other than this; that the rayes emitted from the right ſide of the object, are reflected on the left, and *è Contra.* Juſt as in all Impreſſions, or Sigillations; the right ſide of the Antitype reſponds to the left of the type. *Conſule Aquilonium, lib.* 1. *opt. propoſit.* 46. And, as for the reaſon of the *Reſtitution* of the parts of the Image to the right poſition of the parts of the object; by two Mirrours confrontingly poſited: it may moſt eaſily and ſatisfactorily be explained by the *Decuſſation* of the reflected rayes.

To Conclude. We need not advertiſe, that the *Optical Problems* referrible to this place, are, (if not infinite) ſo numerous, as to require a larger Volume to their orderly Propoſition and Solution, than what we have deſigned to the whole of this our *Phyſiology.* Nor remember you, that our principal Scope in this Chapter, was only to evince the Præeminence of *Epicurus* Hypotheſis above all others, concerning the Reaſon and Manner of Viſion; and this by accommodating it to the Veriſimilous *Explanation* of the moſt Capital *Difficulties*, occurring to a profound inqueſt into that abſtruſe ſubject.

All

All therefore that remains unpaid of our præsent Debt, is modestly to referr it to your equitable Arbitration; Whether we have deserted the Doctrine of the *Aristoteleans*, touching this theorem, and addicted ourselves to the Sect of the *Epicureans*, on any other Interest, but that sacred one of *Verity*: which once to decline, or neglect, upon the sinister prætext of vindicating any Human Auctority; is an unpardonable Profanation of Reason, and high treason against the state of Learning.

CHAP.

CHAP. IV.

THE NATURE OF COLOURS.

Sect. I.

Art. 1. The *Argument* duely acknowledged to be superlatively *Difficult*, if not absolutely *Acataleptical.*

THe *Rabbins*, whenever they encounter any Problem; that seems too strong for their Reason; to excuse their despair of conquering it, they instantly recurr to that proverbial Sanctuary, *Reservatur in adventum Eliæ*, it belongs to the Catalogue of secrets, that are reserved for the revealment of *Elias*. And, ingenously, if any *Abstrusity* in Nature be so impervestigable, as to justifie our open profession of Incapacity, and necessitate our oppreſt Understanding to retreat to the same common Refuge; it must be this of the NATURE OF COLOURS, to the consideration whereof the Clue of our Method hath now brought us. For, though all Philosophers unanimously embrace, as an indubitable verity, that the object of Sight in *General*, is τὸ ὁρατὸν, *Visible*, whatever is deprehensible by that Sense; and that, in *Particular*, the Proper and Adequate object thereof, is τὸ χρῶμα, *Colour*, because nothing is visible but under the gloss or vernish of Colour, nor doth Light it self submit to the discernment of the eye, *quatenus Lux*, in the capacity of its Form, or meerly as Light, but *instar Albedinis*, as it retains to Whiteness; all which *Mersennus* (*opticæ part.* 2. *theorem.* 1.) hath judiciously contracted into this one Theorem, *objectum visus præcipuum est Lux & Color, vel Lux colorata, aut Color lucidus:* we say, notwithstanding this their Ground-work be laid in the rock of manifest Certitude, yet when they attempt to erect thereon an establisht and permanent Theory of the Essence of Colours, either in their simple and first Natures,

Natures, or complex and ſecondary Removes; they find the eye of their Curioſity ſo obnubilated with denſe and impervious Difficulties, that all of certainty they can diſcover, is only this; that their moſt ſubtle indagations were no more but anxious Gropings in the dark, after that, whoſe Exiſtence is evidenced only by, and Eſſence conſiſteth chiefly in Light. But, this Infelicity of our Intellectuals will be more fully commonſtrated by our abridged rehearſal of the moſt memorable Opinions of others, and the declarement of our own, concerning this Magnale.

Art.2. The ſentence of *Ariſtotle*, concerning the Nature of Colours: and the Commentary of *Scaliger* thereupon.

The *Deſpot* of the Schools (*in lib. de ſenſu & ſenſili, cap.3.*) defines Colour to be, ὃ ἐν τοῖς σώμασι διαφανοῦς τὸ ἔσχατον, *the Extremity of a Diaphanum, or tranſparent body terminated:* ſubjoining that Colour appertains to all things, *ratione Perſpicuitatis*, and conſequently, that the extremity of a perſpicuous body terminated is the *Subject* of Colour. Which that we may clearly underſtand, let us conſult the great *Scaliger*, who (*in Exercit.* 325.) thus conciſely Comments thereupon. If the Perſpicuum (ſaith He) ſuffer condenſation ſo far as to the amiſſion of its Tranſparency, and ſo prohibit the trajection of the Viſible Species; it inſtantly becomes Colorate, and ought to be accounted Terminate, becauſe it bounds or limits the Viſive rayes. Wherefore, the law of Conſequence injoineth, that we explore the Eſſence of Colours, in the Gradual Termination of the Diaphanum; and derive that Termination (1) from meer *Condenſation*, without the admixture of any other thing to the Diaphanum; as may be inſtanced in the *Starrs*, for they become viſible, though of a Lucid nature, only becauſe they are of a Compact or Denſe contexture. (2) From the *Admiſsion of an Opace with a Tranſlucid body*; as is exemplified in our *Culunary Fire*, which though in the ſimplicity of its moſt perſpicuous, doth yet appear Red, becauſe commixt and in ſome degree obnubilated with fuliginous Exhalations, from the pabulum or Fewel thereof, or compound body in combuſtion. The ſame likewiſe is to be underſtood of Aer and Water; for, thoſe three Elements are all perſpicuous, though in divers degrees: Fire being moſt perſpicuous, Aer poſſeſſing the next degree, and Water coming behind them both, as ſeeming to be a Medium betwixt Perſpicuity and Opacity. And, therefore, from the admiſſion of the parts of that Opace Element, Earth, to any other of the three Diaphanous, one or other Colour among the many muſt ariſe. But, the Perſpicuum paſſeth firſt into Whiteneſs, and therefore is it that Perſpicuity, Light and Whiteneſs, are of the ſame nature, cozen Germans once removed, and diſcriminate only by Degrees: as, on the contrary, an Opacum, Darkneſs, and Blackneſs are alſo cognate. This being the original of the Two Father, or Ground Colours: it can be no Difficulty to attain the ſpecifical Cauſes of all others, ſince they are only Intermediate, i. e. they ariſe from the various Complexion or Contemperation of the two Extrems. And this is the ſenſe of *Ariſtotles* Text, if we admit the interpretation of *Scaliger*.

Art.3. The opinion of *Plato*.

Plato, being either unable, or unwilling to eraſe out of the table of his mind ſome of the ingravements of *Democritus*; underſtands Colour to be *Flammula quædam, ſive Fulgor, è ſingulis corporibus emicans, partes habens viſui accommodatas* (*in Timæo*). For, having held, as *Diogenes Laertius* (*lib.* 3.) hath well obſerved, and we may eaſily collect from that diſcourſe of his, in the name of *Timæus Locrus*; that the world conſiſteth of the four Elements, of Fire, as it is Viſible, of Earth, as Tangible, of Aer and Water

Water, *ut proportione non vacet* : lest he should apostate from his Fundamentals, He affirmed, *Corpora videri propter Ignem, & propter Terram tangi*, that the Visibility of all things was radicated in their participation of Fire, and their Tangibility in their share of Earth; and consequently that the Colour of bodies was nothing but an Ἐκλάμψις, or *Emicancy of their internal Fulgor*, and the variety of its Species dependent meerly on the various degrees, or more or less of that inhærent luster.

Art. 4. Of the *Pythagorean* and *Stoick*.

As for the *Pythagorean* and *Stoick*; the *Former*, with inexcusable incogitancy, confounded the Tinctures of things with their Extrems, allowing no real difference betwixt the *Superfice*, and the *Colour* it bears. *Pythagoras Colorem esse extimam corporis superficiem censuit, hanc ob Caussam; quod Color Sectilem naturam habet, non tamen sit Corpus, aut Linea :* as *Plutarch* (*de Placit. Philosoph.*) and out of him, *Bernhard. Cæsius* (*de Mineral. lib.* 2. *cap.* 3. *Sect.* 2. *art.*12.). The *Later*, with unsatisfactory subtility, (as if, indeed, He meant rather to blanch over the Ἀκαταληψία, or incomprehensibility of the Subject, with ambiguous and Sophistical Terms, than confess, or remove it.) makes Colour to be Ἐπιφανεία, a certain *Efflorescence*, arising from a determinate Figuration of the First Matter; as we have collected from the memorials of *Plutarch* (*lib.* 1. *de Placit. Philosoph. cap.* 15.)

Art. 5. Of the *Spagyrical* Philosophers.

Lastly, the illuminated *Sons of Hermes*, who boast to have, if not attained to the bottom of the mystery, yet out done the endeavours of all other Sects of Philosophers, in profounding it; confidently lead our curiosity to their general Asylum, the three Universal Principles, *Sal*, *Sulphur* and *Mercury*, and tell us, that the Elemental Salts carry the mighty hand, or most potent Energy in the production of Colours. For, supposing three kinds of Salt in all natural Concretions; the first a Fixt and Terrestrial, the second a Sal Nitre, allied to Sulphur, the Third a Volatile or Armoniac, referrible to Mercury; and that all bodies receive degrees of *Perspicuity*, or *Opacity*, respondent to the degrees of *Volatility*, or *Terrestriety* in the Salts, that amass them: they thereupon deduce their various Colours, or visible Glosses, from the various Commistion of Volatile or Tralucent Salts, with Fixt or obscure.

Art. 6. The reason of the Authors desertion of all these; and election of *Democritus* and *Epicurus* judgment, touching the Generation of Colours.

Now, notwithstanding all these *Sects* are as remote each from other, as the Zenith from the Nadir, in their opinions touching the Nature and Causes of Colours, as to all other respects; yet do they generally Concur in this one particular, εἶναι τὰ χρώματα συμφυῆ τοῖς σώμασιν, *Colores esse Cohærentes corporibus*, that Colours are CONGENITE, or COHÆRENT to bodies. Which being manifestly repugnant to reason, as may be clearly evinced as well from the Arguments alledged by *Plutarch* (1. *adverf. Colot.*) to that purpose, as from the result of our whole subsequent discourse, concerning this theorem : we need no other justification of our Desertion of them, and Adhærence to that more verisimilous Doctrine of *Democritus* and *Epicurus*, τῷ Νόμῳ χρωτῷ εἶναι, *Colorem Lege esse*, or more plainly in the words of *Epicurus*, τὰ χρώματα ἐν τοῖς σώμασιν ὑφάδαι κατὰ τινας τάξεις, καὶ θέσεις, πρὸς τὴν ὄψιν; *Colores in corporibus gigni, juxta quosdam, respectu visus, ordines positusq.* The Probability of which opinion, that we may with due strictness and æquanimity examine; and enlarge what we formerly delivered, in our Origine of Qualities, touching the possible Causes of an inassignable Variety of Colours: We

We are briefly to advertise,

Art. 7. The *Text* of *Epicurus*, fully and faithfully expounded.

First, That by the word, σώμασι, Bodies, we are not to understand *Atoms*, or *simple* bodies, for those are generally præsumed to be devoyd of all Colour; but τὰ συγκρίματα, *Concretions*, or *Compounds*. *Secondly*, that *Epicurus*, in this text, according to the litteral importance thereof, and the Exposition of *Gassendus*, his most judicious and copious Interpreter, had this and no other meaning. That in the Extrems, or superficies of all Concretions, there are such certain Coordinations and Dispositions of their component particles (which, according to our *First Assumption* in the immediately præcedent Chapter, borrowed from the incomparable *Bullialdus*, are never contexed without more or less of Inæquality.) as that, upon the incidence of Light, they do and must exhibit some certain Colour, or other, respective to their determinate Reflection and Refraction, or Modification of the rayes thereof, and the position of the Eye, that receives them. That from these superficial Extancies and and Cavities of bodies are emitted those substantial Effluviaes, constituting the visible Image; which striking upon the primary Organ of Vision, in a certain Order and Position of particles, causeth therein a sensation, or Perception of that particular Colour. But, that these Colours are not really Cohærent to those superficial particles, so as not to be actually separated from them, upon the abscedence of Light: and, consequently that Colours have no Existence in the Dark. Moreover, that the substance of Light, or the minute particles, of which its beams consist, are necessarily to be superadded to the superficial particles of bodies, as the Complement, nay the Principal part of Colour: as may be inferred from these words of *Epicurus*, registred by *Plutarch* (1. *adverf. Colot.*) *Quinetiam hac parte* (*luce*, *viz.*) *seclusa, non video, qui dicere liceat, corpora quæ in tenebris in conspicua sunt, colorem habere.* Of which persuasion was also that admirable Mathematician, *Samius Aristarchus*; who positively affirmed (*apud Stobæum, in Ecl. Phys.* 19.) *Incidentem in subjectas res Lucem, Colorem esse; ideoque constituta in tenebris corpora colore prorsùs destitui.* To which, doubtless *Virgil* ingeniously alluded in his

——————— Ubi Cœlum condidit Umbra
Jupiter, & rebus nox abstulit atra Colorem.

And *Lucretius* in his

Qualis enim cœcis poterit Color esse tenebris,
Lumine qui mutatur in ipso; propterea quod
Recta aut obliqua percussus luce refulget? &c.

And, lastly, that Light doth create and vary Colours, according to the various condition of the minute Faces, or sides of the Particles in the superfice, which receive and reflect the incident rayes thereof, in various Angles, toward the Eye.

Sect. II.

Art. 1. A PARADOX That there are no Colours in the Dark.

HAving thus recited, explicated, and espoused the Conceptions of *Epicurus*, of the Creation of Colours; it behoves us to advance to the Examination of its Consistency with right reason, not only in its *General* capacity, but deduction and accommodation to *Particulars.*

But, First, to prævent the excess of your wonder, at that so Paradoxical assertion of his, *That there are no Colours in the dark*, or that all colours vanish upon the Amotion or defection of Light; we are to observe that it is one thing to be *Actually* Colorate, and another to be only *Potentially*, or to have a *Disposition* to exhibit this or that particular Colour, upon the access of the Producent, Light. For, as the several *Pipes* in an Organ, though in themselves all æqually *Insonorous*, or destitute of sound, have yet an equal Disposition, in respect of their Figuration, to yield a sound, upon the inflation of Wind from the Bellows; and as the seeds of *Tulips*, in Winter, are all equally *Exflorous*, or destitute of Flowers, but yet contain, in their seminal Virtues, a Capacity or Disposition to emit various coloured flowers, upon the access of fructifying heat and moysture, in the Spring: so likewise may all Bodies, though we allow them to be actually Excolor, in the Dark, yet retain a Capacity, whereby each one, upon the access and sollicitation of Light, may appear clad in this or that particular Colour, respective to the determinate Ordination and Position of its superficial particles.

Art. 2. A familiar *Experiment*, attesting the Verity thereof.

To inculcate this yet farther, we desire you to take a yard of Scarlet Cloth, and having extended it in an uniform light, observe most exactly the Colour, which in all parts it bears. Then extend one half thereof in a primary light, *i. e.* the immediately incident, or direct rayes of the Sun; and the other in a secondary, or once reflected light: and then, though perhaps, through the præoccupation of your judgment, you may apprehend it to be all of one colour; yet if you engage a skilful Painter to pourtray it to the life, as it is then posited, He must represent the Directly illuminate half, with one Colour, viz. a bright and lightsome Red, and the Reflexly illuminate half, with another, i. e. with a Duskish or more obscure Red; or shamefully betray his ignorance of *Albert Durers* excellent Rules of shadowing, and fall much short of your Expectation. This done, gently move the extended Cloth through various degrees of Light and shadow: and you shall confess the Colour thereof to be varied upon each remove; respondent to the degree of Light striking thereupon. Afterward, fold the Cloth, as Boyes do paper for Lanterns, or lay it in waves or pleights of different magnitude; and you shall admire the variety of Colours apparent thereon: the Eminent and directly illustrate parts projecting a lively Carnation, the Lateral and averted yeilding an obscure sanguine, clouded with Murrey, and the Profound or unillustrate putting on so perfect sables,

ſables, as no colour drawn on a picture can counterfeit it to the life, but the deadeſt Black. Your *Senſe* thus ſatisfied, be pleaſed to exerciſe your *Reaſon* a while with the ſame Example; and demand of your ſelf; *Whether any one of all thoſe different Colours can be really inhærent in the Cloth?* If you pitch upon the Scarlet, as the moſt likely and proper; then muſt you either confeſs that Colour not to be really inhærent, ſince it may, in leſs than a moment, be varied into ſables, only by an interception of Light: or admit that all the other Colours exhibited, are æqually inhærent; which is more, we præſume, then you will eaſily allow. And, therefore, you may attain more of ſatisfaction, by concluding, that indeed no one of all thoſe Colours is really ſo inhærent in the cloth, as to remain the ſame in the abſence of Light; but, that the ſuperficial particles of the Cloth have inhærent in them (*ratione Figuræ, Coordinationis & Poſitus*) ſuch a *Diſpoſition*, as that in one degree of Light it muſt preſent to the eye ſuch a particular colour; in another degree, a ſecond gradually different from that; in another, a third diſcriminate from both, until it arrive at perfect obſcurity, or Black.

Art. 3. The Conſtancy of all Artificial Tinctures, dependent on the conſtancy of *Diſpoſition* in the ſuperficial Particles of the Bodies that wear them.

And, if your Aſſent hereto be obſtructed by this DOUBT, *Why that Cloth doth moſt conſtantly appear Red*, rather then Green, Blew, Willow, &c. you may eaſily expede it, by admitting, that the Reaſon conſiſteth only herein, that the Cloth is tincted in a certain Liquor, whoſe minute Particles are, by reaſon of their Figure, Ordination and Diſpoſition, comparate or adapted to Refract and Reflect the incident rayes of Light, in ſuch a manner, temperation, or modification, as muſt preſent to the eye, the ſpecies of ſuch a Colour, viz. Scarlet, rather then a Green, Blew, Willow, or any other. For, every man well knows, that in the Liquor, or Tincture, wherein the Cloth was dyed, there were ſeveral ingredients diſſolved into minute particles; and that there is no one Hair, or rather no ſenſible part in the ſuperfice thereof, whereunto Myriads of thoſe diſſolved particles do not conſtantly adhere, being agglutinated by thoſe Fixative Salts, ſuch as Sal Gemmæ, Alum, calcined Talk, Alablaſter, Sal Armoniack, &c. wherewith Dyers uſe to graduate and engrain their Tinctures. And, therefore of pure neceſſity it muſt be, that, according to the determinate Figures and Contexture of thoſe adhærent Granules, to the villous particles in the ſuperfice of the Cloth, ſuch a determinate Refraction and Reflection of the rayes of Light ſhould be cauſed; and conſequently ſuch a determinate ſpecies of Colour, and no other, reſult therefrom.

Art. 4. That ſo generally magnified *Diſtinction* of Colors into *Inhærent*, and *meerly Apparent*; redargued of manifeſt *Contradiction*.

Now, inſomuch, as it is demonſtrated by *Senſe* that one and the ſame ſuperfice doth ſhift it ſelf into various Colours, according to its poſition in various degrees of Light and Shadow, and the various Angles, in which it reflecteth the incident rayes of Light, reſpective to the Eye of the Spectator; and juſtly inferrible from thence by *Reaſon*, that no one of thoſe Colours can be ſaid to be more really inhærent than other therein, all being equally produced by Light and Shadow gradually intermixt, and each one by a determinate Modification thereof: What can remain to interdict our total Exploſion of that *Diſtinction* of Colours into *Real* or *Inhærent*, and *Falſe*, or *only Apparent*, ſo much celebrated by the Schools? For, ſince it is the Genuine and Inſeparable Propriety of Colours, in General,

to be *Apparent*; to ſuppoſe that any Colour Apparent can be *Falſe*, or leſs Real than other, is an open Contradiction, not to be diſſembled by the moſt ſpecious Sophiſtry; as *Des Cartes* hath well obſerved (*in Meteor. cap.* 8. *art.* 8.). Beſides, as for thoſe *Evanid* Colours, which they call Ἐμφαϊκοὶ, *meerly Apparent* ones, ſuch as thoſe in the Rainbow, Parheliaes, Paraſelens, the trains of Peacocks, necks of Doves, Mallards, &c. we are not to account them Evanid, becauſe they are not True: but, becauſe the *Diſpoſition* of thoſe ſuperficial particles in the Clouds, and Feathers, that is neceſſary to the Cauſation of them, is not *Conſtant*, but moſt eaſily mutable; in reſpect whereof thoſe Colours are no more permanent in them, than thoſe in the Scarlet cloth, upon the various poſition, extenſion, plication thereof. And Charity would not diſpenſe, ſhould we ſuppoſe any man ſo obnoxious to abſurdity, as to admit, that the greater or leſs *Duration* of a thing doth alter the *Nature* of it. Grant we, for Example, that the particles of Water conſtituting the rorid Cloud, wherein the *Rainbow* ſhews it ſelf, were ſo conſtant in that determinate poſition and mutuall coordination, as conſtantly to refract and reflect the incident beams of the Sun, in one and the ſame manner; and then we muſt alſo grant, that they would as conſtantly exhibite the ſame Species of Colours, as a Rainbow painted on a table: but, becauſe they are not, and ſo cannot conſtantly refract and reflect the irradiating light, in one and the ſame manner; it is repugnant to reaſon, thereupon to conclude, that the *Inſtability* of the Colours doth detract from the *Verity*, or *Reality* of their Nature. For, it is only *Accidental*, or *Uneſſential* to them either to be varied, or totally diſappear. So that, if you admit that Sea Green obſerved in the Rainbow, to be leſs True, than the Green of an Herb, becauſe its Duration is ſcarce momentany in compariſon of that in the Herb; you muſt alſo admit that Green in the Herb, which in a ſhort progreſs of time degenerates into an obſcure yellow, to be leſs true, than that of an Emrauld, becauſe its Duration is ſcarce momentany, in compariſon of that of the Emrauld.

Art. 5. The *Emphatical*, or *Evanid* Colours, created by Priſms; no leſs *Real* & *Inhærent*, than the moſt *Durable* Tinctures.

But, perhaps, Præjudice makes you yet inflexible, and therefore you'l farther urge; that the Difficulty doth cheifly concern thoſe *Evanid* Colours, which are appinged on Bodies, reflecting light, by *Priſms* or *Triangular Glaſſes*, vulgarly called *Fools Paradiſes*: becauſe theſe ſeem to have the *leaſt* of *Reality*, among all other reputed *meerly Apparent*. And, in caſe you aſſault us with this your laſt Reſerve; we ſhall not deſert our ſtation, for want of ſtrength to maintain it. For, that thoſe Colours are as *Real*, as any other the moſt Durable, is evident even from hence; that they have the very ſame *Materials* with all other, *i. e.* they are the ſubſtance of Light it ſelf reflected from thoſe objected Bodies, and (what happens not to thoſe eyes, that ſpeculate them without a Priſm) twice refracted.

Experience demonſtrates, that if a man look intently upon a polite Globe, in that part of it ſuperfice, from which the incident Light is reflected, in direct lines toward his eye; He ſhall perceive it to appear clad in another Colour, than when He looks upon it from any other part of the Medium, toward which the Light is not reflected: and yet can He have no reaſon, why He ſhould not account both thoſe Different Colours to be *True*; the *Reflection* of light, which

which varieth the Apparition according to the various Position of the eye in several parts of the Medium, nothing diminishing their *Verity*. If so, why should not those Colours created by the Prism, be also reputed *Real*; the *Refraction* of Light, which exhibiteth other Colours in the objected Bodies, than appear in them without that Refraction, nothing diminishing their Reality?

Art. 6. COROLLARY. The Reasons of *Emphatical* Colours, appinged on Bodies objected, by a *Prism*.

By way of COROLLARY, let us here observe; that the Colours created by Light, reflected from objects on the Prism, and therein twice refracted, are *Geminated* on both sides thereof. For, insomuch as those Colours are not appinged but on the *Extremes* of the Object, or where the superfice is *unequal* (for if that be Plane and Smooth, it admits only an Uniform Colour, and the same that appears thereon, when beheld without the Prism): therefore are two Colours alwayes observed in that Extreme of the Object, which respecteth the *Base* of the Triangle in the Glass, and those are a *Vermillion* and a *Yellow*; and two other Colours in that extreme, which respecteth the *Top* of the Triangle, and those are a *Violet blew*, and a *Grass green*. And hence comes it, that if the Latitude of the Superfice be so small, as that the extremes approach each other sufficiently near; then are the two innermost Colours, the Yellow and Green connected in the middle of the Superfice, and all the four Colours constantly observe this order, beginning from the Base of the Triangle; a *Vermillion*, *Yellow*, *Green*, and *Violet*, beside the inassignable variety of other *Intermediate* Colours, about the Borders and Commissures. We say; *Beginning from the Base of the Triangle*; because, which way soever you convert the Prism, whether upward or downward, to the right or to the left, yet still shall the four Colours distinguishably succeed each other in the same method, from the Base: however all the rayes of Light reflected from the object on the Prism, and trajected through it, are carried on in lines parallel to the Base, after their incidence on one side thereof, with the obliquity or inclination of near upon thirty degrees, and Refraction therein to an Angle of the same dimensions; that issuing forth on the other side, they are again Refracted in an Angle of near upon 30 degrees, and with the like obliquity, or inclination.

Art. 7. The true *Difference* of *Emphatical* and *Durable* Colours, briefly stated.

These Reasons equitably valued, it is purely Consequent, that no other *Difference* ought to be allowed between these *Emphatick*, or (as the *Peripatetick*.) *False* Colours, and the *Durable* or *True* ones, than only this; that the *Apparent* deduce their Creation, for the most part, from Light *Refracted* in *Diaphanous* Bodies, respectively Figurated, and Disposed, and sometimes from light only *reflected*: but, the *Inhærent*, or *True* (as they call them) deduce theirs from Light variously *Reflexed* in *opace* bodies, whose superficial particles, or Extancies and Cavities are of this or that Figure, Ordination, and Disposition.

Art. 8. No Colour *Formally* inhærent in objects; but only *Materially*, or *Effectively*: contrary to the constant Tenent of the *Schools*.

Not that we admit the *Durable* Colours, no more than the *Evanid*, to be *Formally* (as the Schools affirm) *Inhærent* in Opace bodies, whose superficial Particles are determinately configurate and disposed to the production of this or that particular species of colour, and no other: but only *Materially*, or *Effectively*. For, the several species of Colours depend on the several *Manners*, in which the minute particles of

of Light ſtrike upon and affect the *Retina Tunica*; and therefore are we to conceive, that opace Bodies, reflecting Light, do create Colours only by a certain *Modification* or *Temperation* of the reflected light, and reſpondent *Impreſsion* thereof on the Senſory: no otherwiſe than as a Needle which though it contain not in it ſelf the *Formal* Reaſon of *Pain*, doth yet *Materially*, or *Effectively* produce it, when thruſt into the skin of an Animal; for, by reaſon of its Motion, Hardneſs, and Acuteneſs, it cauſeth a dolorous ſenſation in the part perforated.

Art.9. The ſame farther vindicated from Difficulty, by the tempeſtive Recognition of ſome præcedent *Aſſumptions* of the Atomiſts.

To diminiſh the Difficulty yet more, we are to recognize; that the *Firſt Matter*, or Catholique Principles of all Material Natures, are abſolutely devoyd of all *Senſible Qualities*; and that the Qualities of *Concretions*, ſuch as *Colour*, *Sound*, *Odour*, *Sapor*, *Heat*, *Cold*, *Humidity*, *Siccity*, *Aſperity*, *Smoothneſs*, *Hardneſs*, *Softneſs*, *&c.* are really nothing elſe but various MODIFICATIONS of the inſenſible particles of the Firſt Matter, relative to the various Organs of the Senſes. For, ſince the Organs of the Sight, Hearing, Taſting, Smelling, and Touching, have each a peculiar Contexture of the inſenſible particles that compoſe them; requiſite it is, that in Concretions there ſhould be various ſorts of Atoms, ſome of ſuch a ſpecial Magnitude, Figure and Motion, as that falling into the Eye, they may conveniently move or affect the Principal Senſory, and therein produce a ſenſation of themſelves; and that either Grateful or Ingratefull, according as they are Commodious or Incommodious to the ſmall Receptaries thereof (for the *Gratefulneſs* or *Ingratefulneſs* of Colours ariſeth from the *Congruity* or *Incongruity* of the particles of the Viſible Species, to the *Receptaries* or ſmall Pores in the Retina Tunica): Some, in like manner, that may be convenient to the Organ of Hearing; Others to that of ſmelling, &c. So that, though Atoms of all ſorts of Magnitude, Figure and Motion contexed into moſt minute Maſſes, arrive at all the Organs of Senſe; yet may the Eye only be ſenſible of Colour, the Ear of Sound, the Noſtrils of Odour, &c. Again, that Colour, Sound, Odour, and all other ſenſible Qualities, are varied according to the various ſituation, order, addition, detraction, tranſpoſition of Atoms; in the ſame manner as Words, whereof an almoſt infinite variety may be compoſed of no more then 24 Letters, by their various ſituation, order, addition, detraction, tranſpoſition; as we have more copiouſly diſcourſed, in our precedent Original of Qualities.

SECT. III.

TO descend to *Particulars*. It being more than probable, that the various species of Colours have their Origine from only the various *Manners*, in which the incident particles of Light, reflected from the exteriours of Objects, strike and affect the principal sensory; it cannot be improbable, that the sense of a *White* Colour is caused in the Optick Nerve, when such Atoms of light, or rayes consisting of them, strike upon the Retina Tunica, as come Directly from the Lucid Fountain, the Sun, or pure Flame; or Reflexedly from a body, whose superficial particles are *Polite* and *Sphærical*, such as we have formerly conjectured in the smallest and hardly distinguishable Bubbles of Froth, and the minute particles of Snow.

Art. 1. The Nativity of *White*; or the reason of its perception by the sight.

And, as for the perception of its Contrary, *Black*; generally, though scarce warrantably reputed a Colour; we have very ground for our conjecture, that it ariseth rather from a meer *Privation* of Light, than any *Material Impression* on the sensory. For, *Blackness* seems identical, or coessential with *Shadow*: and all of it that is positively perceptible, consisteth in its participation of Light, which alone causeth it not to be absolutely Invisible. And hence is it, that we have several *Degrees*, or gradual *Differences* of Black, comparative to the several degrees of shadow, progressing till we arrive at perfect *Darkness*: and that we can behold nothing so black, which may not admit of deeper and deeper blackness, according to its greater and greater recess from light, and nearer and nearer access to absolute Opacity. To reason, therefore, is it consonant that all Bodies, whose natural Hew is *Black*, are composed of such insensible particles, whose surfaces are *scabrous*, rough, or craggy, and their Contexture so *Rare*, or loose, as that they rather *imbibe*, or swallow up the incident rayes of light, than reflect them outwardly toward the eye of the Spectator. Of this sort, the most memorable, yet discovered, is the *Obsidian stone*, so much admired and celebrated among the Romans; whose substance being conflated of scabrous and loosely contexed Atoms, causeth it to appear a perfect *Negro*, though held in the Meridian Sun-shine: because the rayes invading it are for the most part, as it were absorpt and stifled in the small and numerous Caverns and Meanders variously interspersed among its component particles. Which common and illiterate eyes beholding, delude their curiosity with this refuge; that it hath an Antipathy to Light, and doth therefore reflect it converted into shadows.

Art. 2. *Black*, a meer Privation of Light.

The Generation of the Two *Extreme* and *Ground* Colours, White and Black, being attained by this kind of inquest into the Rolls of reason; the *Former* deriving it self from Light; either immediately and in direct lines profluent from its fountain; or by reflection from bodies, whose superficial particles are sphærical and polite; the *Later* from the Negation of Light: there can be no great difficulty remaining concerning the Genealogy of all other INTERMEDIATE ones, since they are but the

Art. 3. The Genealogy of all *Intermediate* Colors.

the off-ſpring of the Extreme, ariſing from the intermiſſion of Light and ſhadow, in various proportions; or, more plainly, that the ſenſe of them is cauſed in the Retina Tunica, according to the variety of Reflections and Refractions, that the incident Light ſuffers from the ſuperficial particles of objects, in manner exactly analogous to that of the Evanid Colours, obſerved in ſphærical Glaſſes, replete with Water, in Priſmes interpoſed betwixt the object and eye, in angular Diamonds, Opalls, &c. For, even our ſenſe demonſtrates, that they are nothing, but certain Perturbations, or Modifications of Light, interſperſed with Umbrellaes, or ſmall ſhadows.

Art. 4. The Cauſes of the *Sympathy* & *Antipathy* of ſome Colours.

The Veriſimility of this may be evinced from the *Sympathy* and *Antipathy* of theſe intermediate Colours, among themſelves. For, the Reaſon, why *Yellow* holds a ſympathy, or ſymbolical relation with *Vermillion* and *Green*, and *Green* with *Sky-colour* and *Yellow*, (as the experience of Painters teſtifieth, who educe a yellow Pigment out of Vermillion and Green, in due proportions commixt, upon their Palatts: and reciprocally, Green out of Yellow and Sky-colour, in unæqual but determinate quantities contempered) is no other but the *Affinity of their reſpective Cauſes*, or only gradually different manners of Light reflected and refracted, and intermixt with minute and ſingly imperceptible ſhadows. And, on the contrary, the Reaſon of the *Antipathy*, or Aſymbolical relation betwixt a *ſaffron Yellow* and a *Cærule*, betwixt a *Green* and a *Roſe colour*, into which a ſaffron yellow degenerates, and betwixt a *Yellow* and *Purple*, into which a Cærule degenerates: can be nothing elſe, but the *Diſſimilitude or Remoteneſs of their reſpective Cauſes*; ſince things ſo remotely Diſcrepant, are incapable of Conciliation into a Third, or Neutral, or (rather) *Amphidectical* Nature, but by the mediation of ſomething, that is participant of both. This the *Philoſopher* glanced at in his; *Colores miſceri videntur, quemadmodum ſoni; ita enim qui eximium quoddam proportionis genus ſervant, hi Conſonantiarum more, omnium ſuaviſsimi ſunt, ceu purpureus & puniceus, &c.* (*de ſenſ. & ſenſil. cap.* 3.)

Art. 5. The intermiſſion of ſmall *ſhadows*, among the lines of Light; abſolutely neceſſary to the Generation of any Intermediate Colour.

We ſay, *that all theſe Intermediate Colours emerge from the various intermiſſion of Light, and ſmall ſhadows*; becauſe, to the production of each of them from reflected, or refracted Light, or both, the interpoſition of minute, and ſeparately inviſible *ſhadows*, is indiſpenſably Neceſſary. Which may be evidenced even from hence, that Colors are not by Priſmes appinged on bodies, but in their *Margines* or Extremes, there where is not only the general Commiſſure of Light and Shadows; but alſo an *Inæquality* of ſuperfice: which, by how much the more ſcabrous or rough, by ſo much the more are the Colours apparent thereon, ampliated in Latitude. For, ſince there is no ſuperfice, however ſmooth and equal to the ſenſe, devoid of many *Extancies* and *Cavities*; as we have more then once profeſtly declared: it is of neceſſity, that betwixt the confronting ſides of the Extancies, reflecting the rays of light hither and thither, there ſhould be intercedent ſmall ſhadows, in the interjacent Cavities, from which no light is reflected. And hence is it, that in an object ſpeculated through a Priſm, the Cærule colour appears ſo much the more Denſe and lively, by how much the nearer to the limbus, or Extreme of the Object it is appinged; becauſe, in that place, is the greater proportion of ſmall ſhadows: and *è contra*, ſo much more Dilute and Pale, by how much farther it recedeth from the

margin

Margin, insomuch that it degenerates, or dwindles at last into weak Sea-Green, or Willow, in its inmost part; because, in that place is the greater proportion of Light. Conformable to that rule of *Athanas. Kircher.* (*Art. Magn. Lucis & Umbræ. lib.* 1. *part.*2. *cap.* 1.) *Differunt autem & Umbra & Fulgores, majore & minore vel candore, & nigrore, prout vel Fonti lucis, aut tenebrarum propriores fuerint, vel à fonte longius recesserint, in quo luce & obscuritate summa sunt utraque. Unde patet, quantò Fulgores a luce magis recesserint, tantò plus Nigredinis; & quantò à tenebris magis recesserint Umbræ, diminuto nigrore, tanto plus albedinis acquirere: quæ omnia Visus judicare potest.* The same, proportionately, we conceive to hold good also in all Bodies, whose Colours are Genuine, or apparent to the naked Eye: chiefly because we may lawfully conceive, that every particle of every hair in a Scarlet, or Violet coloured Cloth, is consimilar in disposition to the particles in the extremes of an Object speculated through a Prism: and hold it purely Consequential thereupon, that light may arrive at the Eye from them, with the like Reflections and Intermistion with shadows, as from the extremes of the Reflectent Body, through the Glass, which advanceth its commixture with small shadows. And what we affirm of Scarlet and Violet, may also, with no less Congruity, be accommodated to Yellow and Sea-Green; allowing the same proportion and modification of Light and Shadows in them as in that part of the superfice of any other body, on which the Prism doth appinge them: and in like manner to all other Colorate objects; whose Tinctures bear any Affinity to either of these four specified, or arise from the Complexion of any two or more of them.

Art.6. Two eminent PROBLEMS concerning the *Generation* and *Transpositi-on* of the Vermillion and Cærule, appinged on Bodies by Prisms.

But here we are arrested by Two notable, and to our præcedent theory seemingly inconsistent PROBLEMS: which though of Difficulty enough to deserve the wealthy speculations of *Archimedes*, do yet require from us at least a plausible Solution, on the pænalty of no less than the loss of reputation, and the posting up a Writ of Bankrupt against our reason, by that austere Creditor, Curiosity.

(1) How comes it, *that those two so discrepant and assymbolical Colours, created by a Prism, Vermillion and Cærule, arise from Causes so Cognate; the former only from the Commistion of a greater proportion of Light with a less of Shadows; the Later from a less proportion of Light with a greater of Shadows?*

(2) *Why, when those two Colours Emphatical, Vermillion and Cærule are by a Prism intermediate, projected on a Wall or sheet of white paper beyond it, from the light of a Candle; if you put your eye in that place, on which either of the two Colours is appinged, so that another person, conveniently posited in the same room, may behold the same distinctly shining on the pupil of your eye; yet shall you plainly and distinctly perceive the other Colour in the Glass?* For Example; *if the Vermillion appear on your eye, you shall nevertheless clearly see a Cærule in the Glass: and transpositively, though your eye be manifestly and totally tincted with a Cærule, yet shall you see a Vermillion.*

Art. 7. The *Solution* of the *Former:* with a rational Conjecture of the Cause of the *Blew*, apparent in the Concave of the Heavens.

Touching the Former, we shall adventure to desume the Solution thereof meerly from the *Figure* of the Prisme, and determine the Reason on this only; that the Rayes of Light arriving at the *Base* of the Triangle, are trajected through it by a longer tract or way, than those arriving at or nearer to the *Top* thereof: and therefore, the Glass being in that part most crass, there must be more impervious particles obsistent to the Rayes of Light; each one whereof repercussing its raye back again into the medium from the Glass, causeth that the number of shadowes is multiplyed in that part of the object, which the Base of the Triangle directly respecteth; and consequently produceth a Cærule Tincture thereon. Such as that, not only by vulgar, but many transcendently learned Heads adscribed to the *Firmament*: which yet belongs rather to that vast (many have said infinite) *Space* betwixt it and our Terrestrial Globe, being caused by the rayes of the Cœlestial Lamps, from swarms of minute bodies interposed, thinly reflected toward our eyes: For, each of those impervious particles swarming in that immense space, must repercuse a ray of Light deradiated from above, and so by multiplying the number of shadows, make the Firmament (which otherwise, according to probability, would wear the mourning livery of Midnight) appear totally invested in an *Azure* mantle.

This, though meer Conjecture (and, indeed, the subject is too sublime to admit of other than conjecture, since St. *Paul* hath left us no observation concerning it, in his rapture up into the third Heaven, and the design of the *Ganzaes* is desperate) hath in it somewhat more of reason, then that confident conceipt of *Athanas. Kircherus* (*Art. Magn. lucis & umbræ, lib.* 1. *part.* 3. *cap.* 3. *de Chromatismis rerum naturalium.*) *Medium inter utrumque Cæruleum, proximum, viz. à nigro, seu tenebroso, colorem ad jucundissima illa Cælorum spatia, inoffenso visu contemplanda, Natura providentissima mundo contulit, &c.* "that the "Providence of the Creator chose this Azure Tincture to invest the "Firmament withal, as the middle colour between the two Extreams, "White and Black, that so our sight might not, when we speculate "that universal Canopy, be either perstringed with the excessive lustre of "the one, nor terminated by the absolute opacity of the other. Because, if the natural Colour of the Firmament were *Azure*, as He præsumes; then would it, by reason of the vast Space betwixt it and our sight, and the repercussion of the greatest part of the rayes of Light, from our eye, by those Myriads of Myriads of Myriads of small bodies replenishing that intermediate Space, necessarily appear of some other colour: the experience of Sea-men assuring, that all Colours, (White and that of pure Flame, retaining to Whiteness, only excepted) lose themselves in long trajection through the medium, and that even Land, which is but few degrees removed from Opacity, appears to the first discovery like a blewish Cloud lying level to the Horizon. It being certain, therefore, that by how much the farther any Colour recedeth from Whiteness, by so much the less way it is visible (which the Græcian intimates in the word, λεύκος, *Albus*, ὡς τὸ λεύσσειν, *quod procul videatur.*) and that even the Earth, an Opace body, to Sea-men first Kenning it, at large distance, appears clad in a kind of obscure blewish Mantle: it cannot bee

dissonant

dissonant to reason to conceive, that the natural Colour of the Firmament cannot be Azure, since it so appears to us; and that it is rather Opace, because it appears Azure, when illustrate by the reflected Light of the Cœlestial Luminaries.

Again, because the rayes of Light; incident on the *Top* of the Prisni; are trajected through it by a shorter cut, or passage, than those incident on the Base; and so meet with fewer impervious and retundent particles; the Glass being in that part thinnest: therefore is the number of shadows much less in that part of the object, which respecteth the Cone or Top of the Triangle, than in that, which confronts the Base; and those few shadows which remain undiminisht, being commixt with a greater number of lines of light; are transformed into the species of a *Vermillion Red.* Such as that daily observed in the impure *Flame* of our Culinary Fires; which having many particles of Fuligenous Exhalations commixt with its pure luminous particles, that continuedly ascending, avert as many rayes of light from the eye of the Spectator, and so in some degree obnubulate it throughout: doth therefore put on the semblance of Redness. Or such as the *Sun* and *Moon*, commonly wear at their rising; when the minor part, though many of their rayes are retused, and averted from our sight, by the particles of dense vapours diffused through the spatious Medium.

However this may be disputed, yet is it warrantable to conceive, that the superficial Particles of all Bodies, clad in either of these Liveries, Vermillion and Cærule, may have in their Contexture obtained such a Disposition, as to reflect Light permixt with small shadows, in that definite Temperation, or Modification, in which it usually arrives at the eye, after its Trajection through a Prism; when it thereupon impresseth the sense of a Vermillion, or Cærule.

Art. 8. The *Solution* of the *Later.*

As for the Enodation of the *Later Difficulty*, it is comprehended in the Reasons of the Former. For, it being certain, that the Vermillion projected by a Prisme, doth consist of a greater proportion of Light mingled with a less of Shadows, and the Cærule, on the contrary, of a greater proportion of shadows interspersed among the lines of a less Light; and as certain, that the Vermillion appeareth on that side of the Prisme, where the Light is more copious, as therein meeting with fewer retundent impervious particles, in the substance of the Glass; and the Cærule in that part, where the Light is diminished, as meeting with more impervious particles, and being by them repercussed: it must inevitably follow thereupon, that, if an *opacous* body be posited within the bounds of this light, so that the light may fall on each side thereof, and as it were fringe it; a symptome quite contrary to the former shall evene, i. e. the Vermillion will appear on that side of the species, which is over against the Cærule, and the Cærule will be transposed to that side of the species, which confronteth the Vermillion. This is easily *Experimented* with a piece of narrow black Ribbon affixt longwise to either side of the Prisme. For, in that case, the light is bipartited into two Borders, or Fringes, the opace part veyled by the Ribbon on each side environed with light, and each border of light environed with two shadows; or, more plainly; between each border of shadows conterminate to each extreme of Light, trajected through the

unopacate parts of the Glaſs: and, therefore, in the commiſſure of each of the two lights with each of the conterminous ſhadows, there muſt be Vermillion on one ſide, and Cærule on the other.

Now to drive this home to the head, the ſolution of the preſent Problem; the *Reaſon* why, when the light of a Candle is trajected through a Priſm, on a White paper or Wall, poſited at convenient diſtance beyond it, and there transformed into theſe two luminous Colours, Vermillion and Cærule, if you put your eye in that place of the Paper or Wall, whereon the Vermillion ſhines, you ſhall perceive only the Cærule in the Glaſs, and *è contra*: we ſay, the Reaſon of this alteration of ſite in the Colours ſeems to be only this, that the circumſtant Aer about the flame of the Candle being opacous, and ſo ſerving in ſtead of two Blacks to environ the borders of light, cauſeth that ſide of the Candle, which is ſeen through the thicker part of the Glaſs, to appear Blew; and that which is ſeen through the thinner, to appear Red; according to the conſtant Phænomenon in Priſmes. But, if the ſpecies be beheld by Reflection from any illuſtrate and repercuſſing Body, ſuch as the paper, or wall, then muſt the ſeries or method of the borders of light and ſhadow be inverted, for the reaſon immediately præcedent, and conſequently, the ſituation of the Colours, emergent from their various contemperations, be alſo inverted.

Art. 9. The Reaſons, why the Author proceeds not to inveſtigate the Cauſes of *Compound* Colours in Particular.

And thus have we, by the twilight of Rational Conjecture, given you a glimpſe of the abſtruſe Original of the *Extreme* and *Simple* Colours; and ſhould now continue our Attempt to the diſcovery of the Reaſons of each of thoſe many COMPOUND ones, wherewith both Nature and Art ſo delightfully imbelliſh moſt of their peices: but, ſince they are as Generally, as rightly præſumed to be only the *multiplied removes of Light and Darkneſs*, i. e. to be educed from the various *Commixtures* of the *Extreme*, or *Simple*, or both; and ſo it cannot require but a ſhort exerciſe of the Intellect to inveſtigate the determinate proportions of any two, or more of the Simple ones, neceſſary to the creation of any Compound Colour aſſigned (eſpecially when thoſe excellent Rules of that Modern Apelles, *Albertus Durerus*, præſcribed in his *Art of Limning*; and the common Experience of Painters, in the Confection of their ſeveral Pigments, afford ſo clear a light toward the remove of their remaining obſcurity, and the ſingling out their particular Natures): we cannot but ſuppoſe, that any greater ſuperſtructure on this *Foundation*, would be lookt upon rather as Ornamental and Superfluous, than *Neceſſary* to the entertainment of moderate Curioſity. Eſpecially when we deſign it only as a decent *Refuge*, for the ſhelter of ingenious Heads from the Whirlwind of *Admiration*: and not as a conſtant *Manſion* for *Belief*.

Art. 10. He confeſſeth the Erection of this whole Diſcourſe, on ſimple *Conjecture*: and enumerates the *Difficulties* to be ſubdued by him, who hopes to attain an *Apodictical* Knowledge of the Eſſence & Cauſes of Colours.

For, as we cautiouſly præmoniſhed, in the *Firſt Article*, the Foundation of it is not layed in the rock of abſolute Demonſtration, or deſumed *à Priori*; but in the ſofter mould of meer *Conjecture*, and that no deeper than *à Poſteriori*. And this we judge expedient to profeſs, becauſe we would not leave it in the mercy of Cenſure to determine, whether or no we pretend to underſtand, What are the proper Figures and other eſſential Qualities of the inſenſible Particles of Light; with what kind of Vibration, or Evolution they are deradiated from their Fountain; What are the determinate Ordinations, Poſitions, and Figures of thoſe Reflectent and Refringent particles

particles in the extreams of Bodies, Diaphanous and Opace, which modifie the Light into this or that ſpecies of Colour; What ſort of Reflection or Refraction, whether ſimple or multiplyed, is required to the creation of this or that Colour; What are the præciſe proportions of ſhadows, interwoven with Light, which diſguiſe it into this or that colour. Beſides, had we a clear and apodictical theory of all theſe niceties; yet would it be a ſuperlative Difficulty for us to advance to the genuine Reaſons, Why Light, in ſuch a manner ſtriking on the ſuperfice of ſuch a body, therein; ſuffering ſuch a Reflection or Refraction, or both, and commixt with ſuch a proportion of ſhadows in the medium, ſhould be transformed into a Vermillion, rather then a Blew, Green, or any other Colour. Again, were our Underſtanding arrived at this ſublimity, yet would it come much ſhort of the top of the myſtery, and it might hazard a dangerous Vertigo in our brains to aſpire to the Cauſes, Why by the appulſe of Light ſo or ſo modified, there is cauſed in the Eye ſo fair and delightful a Senſation; as that of Viſion; and why the ſentient Faculty, or ſoul therein operating, becomes ſenſible not only of the particular ſtroak of the ſpecies, but alſo of the Colour of it.

For, where is that Oedipus, that can diſcover any *Analogy* betwixt the Retina Tunica, Optick Nerve, Brain, or Soul therein reſident, and any one Colour? and yet no man can deny that there is ſome certain Analogy betwixt the *Species* and *Senſory*: ſince otherwiſe there could be no *Patibility* on the one part, nor *Agency* on the other.

Art. 11. *Des Cartes* attempt to diſſolve the chief of thoſe Difficulties; *unſucceſsful:* becauſe grounded on an unſtable *Hypotheſis.*

We are not ignorant, that the aſpiring Wit of *Des Cartes* hath made a towring flight at all theſe ſublime Abſtruſities, and boldly faſtned the hooks of his Mechanick Principles upon them, thinking to ſtoop them down to the familiar view of our reaſon. But ſuppoſing that all Colours ariſe from *the various proportions of the proceſs and circumvolutions of the particles of Light in bodies, reſpective to various Diſpoſitions of their ſuperficial particles, which accordingly more or leſs Accelerate, or Retard them*; as He hath copiouſly declared (*in Dioptric. cap.* 1. *&* *Meteor. cap.* 8.): and erecting this upon his corner ſtone, or grand Hypotheſis, that *Light is nothing but an Appulſe or Motion of the Æther*; or moſt ſubtile, and ſo moſt agile matter in the Univerſe; which is meerly *præcarious*, and never to be conceded by any, who fears to enſnare himſelf in many inextricable Difficulties, Incongruities, and Contradictions, in the deducement of it through all the Phænomena of Light, Colours, and Viſion: all that we can allow him, as to this particular, beſides our thanks for his laborious Endeavours, is that cloſe of Phaetons Epitaph, *Magnis tamen excidit auſis.*

CHAP.

CHAP. V.

THE NATURE OF LIGHT.

Sect. I.

Art. 1. The *Clasp*, or Ligament of this, to the præcedent Chapter.

IN our three immediately præcedent Chapters, we have often mentioned the RAYES OF LIGHT, as the *Material Principle* both of all *Visible Species*, and *Colours*; and that we may not leave our Reader unsatisfied in any particular, the communication whereof seems necessary, or advantageous to His full comprehension of all our Conceptions relating to those Arguments, or any other of Affinity to them, that may hereafter occurr: we judge it our Duty, here to let him clearly know, What Notion we have of the Nature of that so admirably glorious and universally comfortable an Entitie, Light.

Art. 2. The Authors Notion of the *Rays of Light.*

By the *Rayes of Light*, we understand, *certain most tenuious streams of Igneous Particles, in a continued fluor, and with ineffable pernicity succeding each other in direct lines, either immediately from their Lucid Fountain, or mediately from solid bodies reflecting them, towards the eye, and sensibly affecting the same.*

Art. 3. A *Parallelism* betwixt a *stream of Water* exsilient from the Cock of a Cistern, and a *Ray of Light* emanant from its Lucid Fountain.

This *Description* may receive somewhat more both of perspicuity and credit, if we consider the parallelism, or analogy, that each distinct Ray of Light holds to a stream of water, exsilient from the Cock of a Cistern, or tube of an Artificial Fountain. For, the reason why a stream of water issues from a tube in a kind of arch, and flows to some distance from its source through

through the aer; is only this, that the particles of Water first exsilient, upon the remove of the stopple or obstacle, are so closely and contiguously pursued by other particles immediately following, and those again by others indefinently emanant, that they are impelled forward and driven on with such rapidity, as overcomes their natural propensity to direct descent, by reason of their Gravity, and carries them in a tense line from the vent so long as their impulse is superior to that of their Gravity; which encreasing more and more in each degree of distance, doth at length become victor over the force of the Motion, and præcipitate them downright. And as this gradual Tensity, or Rigidity of a stream of Water ariseth to it only from the Pressure or impulse of the Antecedent particles by the Consequent, in an uninterrupted succession: so may we conceeve, that a Ray of Light, or Wand (many of our Modern and most discovering Philosophers call a stream of Light, *Virgula Lucis*; and that by an unstrained Metaphor.) consisting of many rayes seemingly united, such as we observe shining in a room through some hole in the Window, or other inlet; doth therefore become in a manner *Tense*, or *Direct*, only because the particles first emanant from the Lucid Fountain are so urged and prest on by the subsequent, and those again by others, with equal pernicity, that they cannot deflect from a direct line, or obey the inclination of their Gravity, until some solid Body, interposed, cut off the fluor, by interrupting the succession, and then the Tensity, or Pressure ceasing, the Particles become incontiguous and disappear: as is observable, upon closing the inlet, through which a stream of Light is admitted into an otherwise opace room. For, immediately the successive supply of luminous particles being intercepted, the Antecedent droop, fail, and surrender that part of space, which they possest with splendour sufficient to affect the sense, to the horrid encroachment of Darkness.

This full *Comparison* præmised, we shall comply with opportunity, and here concisely observe PRÆCONSIDERABLES.

(1) That *Aquilonius*, and most other *Opticomathematicians* do excellently distinguish Light into so many gradual Differences, as are the Reflections of which it is capable; denominating that Light, *Primary*, whereby a Body is immediately, or in direct lines from the Lucid Fountain, illustrated; that *Secondary*, which reflected from one solid body, illuminates another; that a *Third* Light, which illuminateth a body, after two Reflections from others: and so forward up to the *Centenary*, and *Millenary* light, if, at least, it be capable of so many reflections, from bodies most solid and polite. *Art.* 4. Light distinguisht into *Primary, Secondary, &c.*

(2) That Light at Second hand is more weak than at First; at Third than at Second; at Fourth than at Third, &c. or, that Light becomes so much Weaker, by how many more Reflections it hath suffered. Not (as is vulgarly concluded) that a *Reflex* ray is less Tense, or the successive pressure of its particles less violent or rapid, than those of a *Direct*; for, the motion of Light, however frequently reflected, is incomprehensibly swift: but, that every reflection doth much diminish it, some rayes being always diverted and scattered into other parts of the medium, by reason of the Asperity, or Inæquality of the particles in every superfice; and so there being no superfice that remits in a direct line the full number of rayes (some *Art.* 5. All Light Debilitated by *Reflection*: and why.

(ſome have adventured to ſay, ſcarce half ſo many as) it received, and conſequently the eye receiving fewer and fewer rayes ſucceſſively from every Reflectent, muſt be more weakly affected and moved by the thin remainder. For, if all the rayes of the Sun directly incident on a Wall, were thence reflected on another wall ſituate at a right angle; the Second wall would be fully as luminous as the Firſt; and conſequently, the Secondary light would be as ſtrong and reſplendent as the Primary: but, ſince the ſuperfice of the Firſt Wall is unequal and ſcabrous, it muſt of neceſſity come to paſs, that though many of the rayes incident thereon are from thence projected on the Second, yet as many are repercuſſed into other regions of the Medium, ſome upward, others downward; ſome to the right hand, others to the left, &c. according to the various faces, or ſides of the ſmall particles, with aſperity contexed in the ſuperfice of each ſtone therein. So that one half, if not the major part of the directly incident rayes being diverted from the Second Wall, the Light thereon appearing muſt be proportionately leſs ſtrong and fulgent, than that, which illuminates the Firſt. By the ſame reaſon, if the Second Wall by reverberation derive the Light to a Third; it muſt likewiſe play the Publican, and remit but half ſo many rayes, as it received from the Firſt: and ſo muſt the Third tranſmit a thinner ſtock of light to a Fourth, and a Fourth to a Fifth, &c.

Art. 6 An *Example*, ſenſibly demonſtrating the ſame.

If this Example ſeem ſcarce prægnant enough, let us deſcend into a deep Pit, or with the Troglodites creep into the bowels of ſome ſubterraneous Cavern, and there our ſenſe will demonſtrate, that multiplied Reflections of Light gradually diminiſh it even to abſolute inſenſibility. For, the rayes of the Sun falling into the aperture of either Mine, or long Cave, are by oblique repercuſſions from their ſides conveyed inwards, and ſo often bandied from ſide to ſide, that few or none attain to the bottom to diminiſh the opacity thereof: every reflection remitting ſome rayes, more or leſs, toward the mouth of the pit, or cave. And this uſhers in our Third obſervable.

Art. 7. That light is in perpetual Motion; according to *Ariſt.*

(3) That *Ariſtotles* aſſertion, *Lumen eſſe in continuo motu*, that Light is in perpetual motion, or reverberated to infinity; is profound and orthodox. For, notwithſtanding the illuſion of our ſenſe perſuades us, that all things in the aer about us, and within our houſes, are calm and unmoved: yet doth that better Criterion, our Reaſon, aſſure that the Light diffuſed through the aer is in perpetual inquietude, and conſiſteth of nothing elſe but a moſt tenuious Contexture of innumerable rayes, ſwarming from and to all regions unceſſantly, ſo long as the Lucidum ceaſeth not to maintain the ſucceſſion of freſh rayes, that may be reflected from all obvious bodies. So that in what ever part of the medium the eye is poſited; it ſhall ever have ſome object or other præſented: and particularly that, from whence ſome rayes are more directly reflected into its Pupil. Not that we conceive the Light diffuſed through the whole aer to be Continued, or United in all points, as are the parts of Water in the Sea: but, that, as a Spiders Web appears to be one entire and united body, though it conſiſt of diſtinct Filaments, variouſly intricate, and mutually decuſſating each other; ſo alſo is Light, *Non unum quid Simpliciſsimum, ſed Compoſitiſsimum*, ſome one thing not moſt Simple or conſiſting of parts continuedly united, but moſt Compound, or conſiſting of parts ſo interwoven as to exclude all ſenſible diſcon-

discontinuity; though our sense deprehend it to be *Incompositissimum*; because the acies of the sight is too blunt to discern the single rayes, which like most slender Filaments with exquisite subtilty interwoven into a visible invisible Web, replenish the whole Medium.

(4) That, though Light be ever *debilitated* by *Reflection*, yet is it many time *Corroborated* by *Refraction*; as that transmitted through Convex Glasses, and Glass Vials replete with limpid water: and then only debilitated, when it is Refracted by a Concave superficies of a pellucid body, or after refraction on a Plane superfice, is lookt upon obliquely. For as no reason can be given for the Debilitation of Light by Reflection; but the Attenuation or Diminution of the number of its Rayes: so can none be assigned for the Corroboration of it by Refraction in a Convex Glass, or Vial filled with clear water; but the *multiplication* of its Rayes, in some part of the Medium. Nor is there, on the contrary, why we should conceive Light to be made weaker by some Refraction, unless in this respect only; that if it had not fallen foul of a Refringent body, a greater number of rayes would have continued their direct progress in a closer order, or more united stream: and so their Debility depends meerly on their Disgregation; not Diminution of Pernicity. Certainly, that Light which is corroborated by refraction in a Convex Glass, would be yet more strong and energytical, if all those Rayes, that strike upon the obverted side of the Glass, were so refracted, as to permeate and unite in the aer beyond the averted side thereof: and those rayes which are trajected through the bottome of a Glass Vial filled with water, arrive at the eye so much the more Disgregate, by how much the more obliquely the eye is posited; because the water being in the bottom more copious, and so containing more retundent particles, doth divert the greatest number of them into the ambient. And hence we inferr, that if the beams of the Sun be conceded more weak in the Morn and Evening than at Noon, only because of a greater Refraction by more vapours then interposed; that effect must chiefly arise from hence, that the Rayes come unto us obliquely, after their trajection through those swarms of denser vapours, and consequently more Dissipated, the major part of them being diverted into other regions of the Medium. Moreover, insomuch as all *Masters in the Optiques* clearly demonstrate that the Image of an illustrate object, speculated through water in the bottome of a vessel indiaphanous, doth appear less lively to those, that look on it obliquely, than to those that behold it in direct lines respective to the tendency of the Light refracted by the Water; and that the superfice of every object hath so much the fewer parts discernable, by how much more obliquely it is speculated: therefore is it purely necessary, that the Image of an object appear more *Contracted*, when speculated by a *Vertical* line, than when exhibited to the eye in a *direct*, and Irrefracted one. And this also we judge to be in some part the Cause, why the Sun when neareſt to our Horizon, either Orient or Occident, appears in a Figure more Elliptical or Oval, than Sphærical: for then do we behold it *per lineam Verticalem*. We say, *in part*; because the same Effect may also be induced by the Form of the Vaporous Sphære. However this may be controverted, yet most certain it is, that the Lucid Image of the Sun is alwayes more *Vitiated*, when it arrives at our sight from an *Humble* position, than a sublime or Meridional: *Non quod pauciores quidem radij Directi mane, quàm meridie; sed reflexi tamen pauciores, qui cum illis misceantur, ipsorumq; Vim augeant.*

Art. 8. Light, why *Corroborated*, in some cases, and *Debilitated*, in others, by *Refraction*.

COROLLARY. Why the Figure of the Sun, both rising & setting, appears rather *Elliptical*, than Sphærical.

augeant. Quia Directi supra liberam horizontis planitiem prætereant, nec redeant; cum sub meridiem in terram impacti non resilire regredique non valeant; as *Gassendus, in Epist. ad Bullialdum, de Apparent. Magnitud. Solis Humilis & sublimis.* And this hath a near relation to our fifth observable.

Art. 9. PARADOX. That the proportion of Solary Rayes reflected by the superiour *Aer*, or *Æther*, toward the Earth, is so small, as not to be sensible.

(5) That the Body from which the rayes of a Lucid object more eminently the Sun, are repercussed so as to diminish the shadow round about it, seems not to be the Conterminous Aer, but rather some *Opacum* constitute beyond both it and the Aer. Not that we deny the necessary reflection of many of the Luminous rayes proceeding from the Sun, by those myriads of myriads of particles floating in the Atmosphere; and so the remission of them back again toward their source, and the consequent diminution of the shadow invironing the same: but that we conceive the proportion of rayes so diverted, to be so small, as to be much below the observation of our sense. For, He that is in the bottom of a deep Mine, hath his sight so little advantaged by the Aer illuminated by the meridian beams of the Sun, that though he can clearly behold the Starrs in the Firmament, immensely beyond that vast tract of Aer then illustrate; yet can he hardly perceive his own hand, or ought else about him, since all the rayes of Light, which affect his eyes, are only those few that have escaped repercussion upward, by those many oblique refractions in the sides of the Mine. Thus also in the night are we no whit relieved by the aer, or Æther surrunding our Horizon, or more properly, our Hemisphere beyond that region, to which the Cone of the Earths shadow extends: though the Sun doth as freely and copiously diffuse its light through all that vast Ocean of Aer, or Æther beyond the extent of the Earths shadow, at our Midnight, or when it is Vertical to the Antipodes, as at our noon when it is Vertical to us: which could not be, if any sensible proportion of light were reflected toward us by the particles of the Aer, or Æther, replenishing the subcælestial space. Hence comes it, that what Light remains to our Hemisphere in the night, ought to be referred, not to any Reflection of the Suns rayes from the sublime aer, or Æther; but to the Stars, or Moon, or both. And this is also no contemptible argument, that the Concave of the Firmament is *Opace*, and not azure, as most suppose.

Art. 10. That every Lucid Body, as *Lucid*, doth emit its Rayes *Sphærically*: but, as *Visible*; *Pyramidally*.

(6) That every Lucid Bodie is considerable in a double capacity; (1) *Qua Lucidum*, as shining with either native, or borrowed light, it illuminateth other bodies: (2) *Qua Visibile*, as it emits the visible Image of it self. In the *First* Respect, we may conceive it to be the *Center*, from which all its luminous Rayes are emitted by Diffusion *Spherical*, according to that establisht maxime of *Alhazen*, *Omne punctum luminosum radiare sphæralitèr*: in the *Second*, we may understand it to emit rayes in a diffusion *Pyramidal*, the base whereof is in it self, and cone in the eye of the Spectator. For, particularizing in the Sun, which being both a Lucid Body and a Visible object, falls under each acceptation; we must admit the Rayes thereof illuminating that vast ocean of Space circumscribed by the concave of the Heavens, to be deradiated from it sphærically, as so many lines drawn from one common Centre; because they are diffused throughout a region far greater than the Sun it self: and those rayes, that Constitute the Visible Images of it, stream from it in Cones or pyramids; because they are terminated in the pupil of the beholders eye, a body by almost infinite degrees less

leſs than it ſelf. This is fully demonſtrated by the Forms of Eclipſes, which no man can deſcribe but by aſſuming the Sun as the Baſe, from whoſe Extremes myriads of Rayes emanant, and in their progreſs circularly environing the Margin of the Earth, or Moon, paſs on beyond them till they end in a perfect Cone; the Orbs of the Earth and Moon being by many degrees leſs in circumference, than that of the Sun. This confirms us, that thoſe *Optico-mathematicians* are in the centre of truth; who teach, that the rayes of the Sun, and all other luminous Objects as they conſtitute its viſible ſpecies, are darted only Pyramidally; inſomuch as they are received in the eye of each Spectator, ſo much leſs than the Sun, or other Luminary: but that they progreſs in a ſphærical Diffuſion, in reſpect of the circumambient Aer, in each point whereof the Luminary or Lucidum is Viſible. Since, ſhould we allow the Concave of the Firmament to be as thickly ſet with eyes, as Joves vigilant Pandars head was imagined by Poets; we could not comprehend how the orb of the Sun could be diſcernable by them all, unleſs by conceding this ſphærical diffuſion of Pyramids to all parts of the ſame. And this doth as well illuſtrate as confirm a former *Antiperipatetical Paradox* of ours, that the viſible Species of an object is neither total in the totall Space, nor total in every part thereof; but the General Image is in the whole Medium, and the Partial or Particular Images, whoſe Aggregate makes the General Image, in the ſingular parts of the Medium: becauſe no ſingular eye from any ſingular part of the Medium, can perceive the whole of the object, but thoſe parts only, which are directly obverted to that part of the Medium, in which the eye is poſited. Which aſſertion we inferred from hence, that not only the whole, but alſo every ſenſible particle of an object doth emit certain moſt ſubtile rayes, conſtituting the ſpecies of it ſelf, in a ſphærical diffuſion, ſo that the various particles emit various rayes, that variouſly decuſſate and interſect each other, in all parts of the Medium: and as theſe rayes are emitted ſphærically, *ex ſe*, according to that maxime, *Omne Viſibile ſui ſpeciem effundere ſphæraliter*; ſo do moſt of them, *ex Accidente*, convene in their progreſs, and ſo reciprocally interſect, as to fulfill the figure of a Pyramid. Whence it naturally follows, that becauſe ſome Rayes muſt convene, in all parts of the Medium, in this manner; therefore are Pyramids of rayes made in all points of the Medium, from whence the object diffuſing them is viſible. Notwithſtanding this, we ſhall ſo farr comply with the Vulgar doctrine, as to allow; that in reſpect even of *one ſingle eye*, in whatever part of the Medium poſited, the diffuſion of rayes from an object may be affirmed to be *Sphærical*: inſomuch as no part in the object at conſiderable diſtance ſingly diſcernable, can be aſſigned, which is not leſs than the pupil of the Eye.

Art. 11. That Light is inviſible in the pure medium.

(7) That the Light diffuſed through the Medium, is not ſeen by us: but that thing beyond the Medium from which ſome rayes are ultimately reflected into the eye. For, if it chance that we perſuade our ſelves, that we perceive ſomething in the Medium; it is not pure Light it ſelf; but ſome craſs ſubſtance, the ſmall particles of Duſt, Vapours, Smoak, or the like, which having received light from ſome luminous ſource, reflect the ſame toward the eye.

Sect. II.

Art. 1. The Necessity of the Authors confirmation of the *First Præconsiderable*

NOw, of all these Præconsiderables only the *First* can be judged *Præcarious*, by those whose Festination or Inadvertency hath not given them leave to observe the Certitude thereof inseparably connected to the evidence of all the others, by the linkes of genuine Consequence. And therefore, that we may not be wanting to them, or our selves, in a matter of so much importance, as the full Confirmation of it by nervous and apodictical Reasons; especially when the Determination of that eminent and and long-lived Controversie concerning the QUIDDITY or Entity of *Light*, *Whether it be an Accident*, *or Substance*, *a meer Quality*, *or a perfect Body?* seems the most proper and desiderated subject of our præsent speculations, and the whole Theory of all other sensible Qualities (as Vulgar Philosophy calls them) is dependent on that one cardinal pin, since Light is the neareſt allied to spiritual natures of all others, and so the most likely to be Incorporeal: we must devote this short Section to the perspicuous Eviction of the CORPORIETY of Light.

Art. 2. The CORPORIETY of Light, demonstrated by its just *Attributes*: *viz.*

Not to insist upon the grave Authority either of *Empedocles*, who, as *Aristotle* (1. *de sensu & sensili: & de Gener. Animal.* 1. *cap.* 8.) testifieth, affirmed Light to be Ἀπόρροιαν, *Effluxionem*, a material Emanation, and required certain proportionate Pores, or most slender passages in all Diaphanous bodies, for their transition; or *Plato*, who defined Colour, or Light disguised, to be φλόγα ἀπορρέουσαν, *Effluentem quandam Flammulam*; or of *Democritus* and *Epicurus*, both which are well known to have been grand Patrons, if not the Authors of that opinion, that Light is corporeal: we judge it alone sufficient to demonstrate the Corporiety of Light, that the Attributes thereof are such, as cannot justly be adscribed to any but a Corporeal Entity.

1. Locomotion.

Such are (1) *Locomotion*; for manifest it is, that some substance, though most tenuious, is deradiated from every Lucidum to the eye of the distant Spectator: nor is a Bullet sent from the mouth of a full charged Cannon with the millionth part of such velocity, as are the arrows shot from the bow of *Apollo*; since the rayes of the Sun are transformed from one end of the heavens to the other, in a far less division of time, than a Cannon Bullet is flying to its mark.

2. Resilition.

(2) *Resilition*; for the rayes of light are sensibly repercussed from all solid bodies, on which they are projected; and that with such pernicity or rapid motion, as transcends, by inassignable excesses, the rebound of a Cannon Ball from a Rock of Adamant.

3. Refraction.

(3) *Refraction*, for our sense confirms, that Light is ever refracted by those Bodies, which allow its rayes a passage, or through-fare, but not an absolute free and direct one.

(4) *Coition*

(4) *Coition*, or Union, or Corroboration, from bodies either reflecting, or transmitting many rayes to one common point of concurse, where they become so violent as to burn any thing applied. 4. Coition.

(5) *Disgregation* and Debilitation, from the didaction of its rayes reflected or trajected: so that those which before during their Union were so vigorous as to cause a conflagration, being one distracted become so languid as not to warm. 5. Disgregation.

(6) *Igniety*; since Light seems to be both the Subject, and Vehicle to Heat, and those speak incorrigibly, who call Light, Flame attenuated. Which we shall less doubt, if we consider the natural Parallelism betwixt *Flame* and *Water*, *Light* and a *Vapour*. For, as Water by Rarefaction, or Attenuation becomes a Vapour; so may we conceive Flame by Attenuation to become Light circumfused in the aer: and as a Vapour is nothing else but Water so rarefied into small discontinued particles, as that it doth scarce moisten the body on which it is impacted; so is Light nothing else but Flame so dilated by Rarefaction, that it doth hardly warm the body it toucheth. Lastly, as a Vapour how finely soever rarefied, is still substantially Water; because only by the Coition of its diffused particles it returns again to Water, as in all distillations: so must we account Light however rarefied, to be still substantially Flame; because only by the Coition, or Congregation of its dispersed rayes it is reducible into absolute Flame, as in all Burning-glasses. 6. Igniety.

These Attributes of Light considered, it is not easie for the most prævaricate judgment not to confess, that Light is a Corporeal substance, and the Rayes of it most tenuious streams of subtle Bodies: since it is impossible they should be deradiated from the Lucid Fountain with such ineffable pernicity, transmitted through the Diaphanum in a moment, impacted against solid bodies, repercussed, corroborated by Unition, debilitated by Disgregation, &c. without essential Corpulency.

Notwithstanding this apodictical evidence of the Corporiety of Light, the refractary *Peripatetick* will have it to be a meer *Quality*, and objects.

(1) That his master *Aristotle*, impugning the doctrine of *Democritus*, *Epicurus*, and others, who ascribed Materiality to Light, defined it to be meerly Ἐνεργείᾳ *perspicui*, an *act of the Perspicuum*. *Art. 3.* *Aristotles* Definition of Light, a meer *Ambage*, and incomprehensible.

To this we answer, (1) That though *Aristotle* thought it sufficient barely to deny that light is Ἀπορροὴ σώματος οὐδενός, *ullius corporis Effluxum*, and to affirm it to be *Energian perspicui*, *ut perspicuum*; yet will the judicious discover it to be rather an ambage to circumvent the incircumspect, than a demonstration to satisfie the curious. For, though *Philoponus* (2. *de Anim.* 7.) willing to conceal or guild over his Masters error, interpreteth his *Perspicuum actu*, or illustrate Nature, and so Light to be a kind of Chord, which being continuedly interposed betwixt the object and the eye, causeth that the Colour thereof posited beyond the Medium, doth affect and move the eye to the act of intuition: yet hath He left the *Reason* and *Manner* of this supposed Act of

of the Perſpicuum on the eye, the chief thing neceſſary to ſatisfaction, involved in ſo many and great Difficulties, as proclaim it to be abſolutely inexplicable. (2) That albeit we deny not *Illumination* to be meerly *Accidental* to opace Bodies; yet therefore to allow the *Light*, wherewith they are illuminate, to be an Accident, and no Subſtance, is a manifeſt Alogie. And to affirm, that the Aer, Water, or any Diaphanous body is the *ſubject of Inhæſion* to Light, is evidently incongruous; becauſe every Medium is ſimply *Paſſive*, and remains unmoved while the Light pervades it: and how can Light pervade it, if it be not Corporeal? or how can the rayes thereof conſerve their Tenſity and Directneſs in the Aer, while it is variouſly agitated by wind and other cauſes, if they were not abſolutely independent thereupon? (3) What *Ariſtotle* ſaith concerning the *Propagation* of the ſpecies of Light even to infinity in all points of the *Medium*, beſides its incomprehenſibility, is abſolutely inconſiſtent to the *Pernicity* of its motion, which is too rapid and momentany to proceed from a freſh Creation of Light in every point of the medium: ſince the multitude of freſh productions ſucceſſively made, would require a far longer time for the tranſmiſſion of the light of a candle to the eye of a man at the diſtance of but one yard, than our ſenſe demonſtrates to be neceſſary to the tranſmiſſion of the light of the Sun from one end of Heaven to the other.

Art. 4. The Corporiety of Light imports not the Coexiſtence of two Bodies in one Place: contrary to the *Peripatetick.*

(2) *That by allowing Light to be Corporeal, we incurr the abſurdity of admitting two Bodies into one and the ſame place.*

Which is ſoon ſolved by reflecting on what we have formerly and frequently ſaid, concerning *Inanity interſperſed*, and obſerving what we ſhall (God willing) ſay of thoſe eminent Qualities, *Rarity and Perſpicuity*: from either of which it may be collected, how great a Multitude of Pores are in every Rare and Perſpicuous Body, which remain tenantable, or unpoſſeſſed.

Art. 5. Nor the motion of a Body to be *Inſtantaneous.*

(3) That from the Corporiety of Light it muſt follow, *that a Body may be moved in an Inſtant.* But he hath not yet proved that the motion of Light is *inſtantaneous*: and we have, that it is not, but only Momentany, i. e. that Light is moved in a certain ſpace of time, though imperceptible, yet diviſible, and not in one individual point, or Inſtant.

Art. 6. The *Inviſibility* of Light in the limpid medium, no Argument of its *Immateriality*: as the Peripatetick præſumes.

(4) *That the Rayes of Light are Inviſible in pure Aer, and by conſequence Immaterial. Solut.* Their Inviſibility doth not neceſſitate their Immateriality; for the Wind, which no man denies to be Corporeal, is inviſible: and as it ſufficeth that we feel the Wind in its progreſs through the aer, ſo alſo is it ſufficient that we perceive Light, in the illumination of Opace Bodies, on which it is impinged, and from which it is reflected. Beſides, whoſo maketh his ſenſe the meaſure of Corporiety, doth ſtrain it to a higher ſubtility, than the conſtitution of its Organs will bear, and make many more ſpiritual Entities, than can be found in the Univerſe; nay, He implicitely ſuppoſeth an Immaterial Being naturally capable of Incorporation meerly by the Unition of its diſperſed particles; ſince many rayes of Light congregated into one ſtream become viſible.

(5) *That*

(5) *That the Materiality of Light is repugnant to the Duration of the Sun; which could not have lasted so long, but must have, like a Tapour exhausted its whole stock of Luminous Matter, and wincked out into perpetual night, long since, if all its Rayes were substantial Emanations*, according to our Assumption.

Art. 7. The Corporiety of Light fully consistent with the *Duration* of the Sun: contrary to the *Peripateticks*.

But this Refuge may be battered with either of these two shots. 1 The superlative *Tenuity* of the Luminous particles continually emitted from the body of the Sun, is such as to prevent any sensible minoration of its orb, in many 1000 yeers. (2) If the Diametre of the Sun were minorated by 100000 miles less than it was observed in the days of *Ptolomy*; yet would not that so vast Decrement be sensible to our sight: since being in its Apogæum, in summer, it doth not appear one minute less in Diameter to the strictest astronomical observation, than in winter, in its Perigæum, and yet *Snellius*, *Bullialdus*, and *Gassendus*, three Astronomers of the highest form, assure us that it is about 300000 miles more remote from us, in its Apogæum, than Perigæum.

(6 and Lastly) *That if Light were Flame, then would all Light warm at least:* but there are many Lights actually Cold, such as that in the *Phosphor Mineralis*, or *Lapis Phenggites*, of whose admirable Faculty of imbibing, retaining and emitting a considerable light, the excellent *Fortunius Licetus* hath written a singular Tract, and *Athanas. Kircherus* a large chapter (*in Art. magn. Lucis & Umbræ lib.* 1. *part.* 1. *cap.* 8.), in Gloworms, the scales and shells of some Fishes, among which the most eminent are those *Dactyli* mentioned by *Kircher* (*in libri jam citati part.* 1. *cap.* 6.) in these words, *sunt & Dactyli, ostreacei generis, qui vel manibus triti lumen veluti scintillas quasdam ex se spargunt: quemadmodum Melitæ, in Sicilia, Calabria, & Ligustici maris oris non sine admiratione à piscatoribus & nautis instructoribus observasse memini*; in Rotten Wood, &c. Ergo, &c.

Art. 8. The insensibility of Heat in many Lucent Bodies, no valid Argument against the præsent Thesis, that *Light* is *Flame* Attenuated.

Answer, The Defect of actual Heat in these things, doth arise, in part from the abundant commistion of Gross and Viscid Humidity with those igneous Particles that are Collucent in them; but mostly from the exceeding *Rarety* of those Luminous Sparks: which being so thin and languid, as to disappear even at the approach of a Secondary Light, cannot be expected vigorous enough to infuse an actual warmth into the hand that toucheth them; especially when experience attesteth, that the Rayes of the Sun, after two Reflections, become so languid by Attenuation, as they can hardly affect the tenderest hand with any sensible Heat. And therefore, unless it can be evinced, that the disgregation of the parts of a Body, doth destroy the Corporiety of it; and that the simple Attenuation of Light doth make it to be no Light: we ask leave to retain our persuasion, that the existence of many lights, which are devoyd of Heat, as to the perception of our sense, is no good Argument against the Igniety and Corporiety of Light.

CHAP.

CHAP. VI.

THE NATURE OF A SOUND.

Sect. I.

Art. 1. An Elogy of the ſenſe of *Hearing*: and the *Relation* of this and the præcedent Chapter.

IT was a hypochondriack conceit of *Plato*, that all our *Cognition* is but *Recognition*, and our acquired *Intellection* a meer *Reminiſcence* of thoſe primitive leſſons the Soul had forgotten ſince her tranſmiſſion ftom the ſphere of ſupreme Intelligences, and Immerſion into the Opacity of Fleſh. For, *Proper Science* is proper only to *Omniſcience*; and not to have knowledge by infuſion or acquiſition, is the attribute only of the *Eſſence of Wiſdom*; and a priviledge due to none but the *Ancient of Dayes*, to have his knowledge derived beyond Antiquity: but *Man*, poor ignorant Thing, ſent to School in the World, on the deſign of Sapience, muſt ſweat in the exploration and purſuit of each ſingle Verity; nor can he ever poſſeſs any ſcience, in this dark region of life, but what he hath dearly purchaſed with his own anxious diſcovery, or holds by inhæritance from the charitable induſtry of his Fore-fathers. And, that the naked Mind of man, endowed only with a ſimple Capacity of Science, might by degrees adorn it ſelf with the notions of whatever concerns his well-being either in this ſtate of Mortality, or that future one of Immortality; hath the Bounty of his Creator furniſhed him with the Senſe of HEARING: a ſenſe particularly and eminently ordained for *Diſcipline*. For, though we ſing Hymns to the *Eye*, for the *Invention*: yet muſt we acknowledge a ſacrifice of gratitude due to the *Ear*, for the *Communication* and Diffuſion of Arts and Sciences. *Quemadmodum aſpectus ad vitæ dulcedinem, & commoda eſt magis neceſſarius; ita*

ita Auditus ad excipiendam artem, scientiam, & sapientiam est accommodatior: ille ad inventionem, hic ad communicationem aptior est; saith that accurate and eloquent Anatomist, *Julius Casserius Placentinus*, (*in premio ad libr. de sens. organ.*). Thus much the antique *Ægyptians* intimated in their Hieroglyphick of Memory, the figure of a mans Ear; and the *Philosopher* exprest in his Character of the Hearing, *Auditus est sensus Disciplinæ*; as also that Modern Ornament of Germany, *Sennertus* (*in hypomn. Phys.*) in this memorable sentence; *Aures in homine quasi porta mentis sunt, per quam illi communicantur, quæ doctrina & institutione de Deo, & alijs rebus necessarijs traduntur, queque nullo alio sensu addisci possunt.* Now, to bring you home to the scope of this (not otherwise or unreasonable, or unnecessary) Elogy of the Hearing; since the Relation betwixt the Sight and Hearing is so great, as to the point of mans acquisition of Knowledge, as that the one can be no more justly called the Discoverer, than the other the Propagator of all Arts and Sciences: it is evident we have made no undecent Knot in the Clue of our Method, by immediately subnecting this Enquiry into the Nature of a Sound, the adæquate and proper object of the Hearing, to our præcedent speculations of the Nature of Vision, Colours, and Light.

Art. 2. The great *Affinity* betwixt *Visible* and *Audible* species; in their representation of the superficial Conditions of Objects.

Besides, as these two Senses are Cousin-Germans, in their *Uses* and *Ends*: so likewise are they of near Alliance, in their *Objects*; there being no small, nor obscure *Analogy*, betwixt the nature and proprieties of a *Visible Species*, and the nature and proprieties of an *Audible Species*, or Sound. For

(1) As it is the property of *Light*, transfigured into Colours, to represent the different Conditions or Qualities of bodies in their superficial parts, according to the different Modification and Direction of its rayes, either simply or frequently reflexed from them, through the Aer, to the Eye: so is it the propriety of *Sounds* to represent the different Conditions or Qualities of Bodies, by the mediation of the Aer percussed and broken by their violent superficial impaction, or collision, and configurate into swarms of small consimilar masses, accommodable to the Ear. So that He speaks as Philosophically, who saith; that various sounds are no more but the various Percussions and impreſt Motions of the Aer: as He that saith, Colours are no more then the various Immersions of Light into the superficial particles of bodies and respective Emersions or Reflections from them, through the diaphanous medium to the Eye. Nor can we much dislike the conceipt of *Athanas Kircher.* (*Musurgiæ Universalis l. 9. part. 4. præluf. 1.*) that if it were possible for a man to see those subtle motions of the aer, caused by the strings of an instrument, harmonically playd upon (as we may the Circular Undulations, and Tremblings of water, raised by a stone thrown into it, in a river or standing lake) the whole Tune would appear to him like a well drawn Picture, ingeniously and regularly adumbrate with admirable variety of Colours, each one distinctly representing the particular Condition of that string or sonant Body, that created it.

Art. 3. In the Causes and manner of their *Destruction.*

(2) As *Light* immediately fails and disappears upon the remove or eclipse of its lucid fountain; as is manifest by the succession of darkness in a room at night, when a candle is either removed out of it or extinguished;

the ſucceſſion of its rayes being intercepted: ſo doth a *Sound* inſtantly periſh upon the Ceſſation of the undulous motion of the Aer, which conduceth not only to the Creation, but Delation of it, as the principal, if not the ſole Vehicle. For, the ſubſiſtence of Sounds is not by way of dependence upon the ſolid bodies, by which they were produced; according to the 7 *Propoſit.* of *Merſennus* (*Harmon. lib.* 1. *pag.* 3.) *Soni non pendent à corpore, à quo primum producti ſunt:* but upon the Continuation of the motion impreſt upon the Aer, ſo that the Duration of a Sound is equal to the duration of the Agitation of the aer. And therefore *Bapt. Porta*, *Cornelius Agrippa*, *Wecherus*, *Alexius*, and others of the ſame tribe, that ſo highly pretend to *Phonocamptical Magick*, are worthy more than deriſion, for their inſolent undertaking to Conſerve a voice, or articulate ſound of many ſyllables, by including it in a long Canale of Lead, or other impervious matter; ſo that upon unſtopping the extreme of the Tube, after many not only hours, but months, the voice ſhall iſſue out as quick and diſtinct as at the firſt pronunciation, or inſuſurration into the cavity thereof. Which (whether more impudent, or ignorant (for both Experience and the Nature of a Sound evidence the contrary) is diſputable) Rhodomantade is demonſtrated to be abſolutely impoſſible, by *Athanaſ. Kircher.* (*Muſurgiæ Univerſal. lib.* 9. *& Magiæ Echotectonicæ cap.* 1.) whether we remit the unſatisfied.

Art. 4. In their *Actinoboliſm*, or Diffuſion, both *Sphærical* and *Pyramidal.*

(3) As the Actinoboliſm, or Deradiation of Light from the Luminary, is *Sphærical*, in reſpect of the circumambient ſpace illuminate by it: ſo is the Diffuſion of a Sound in *excentral* lines from the ſonorous body, through the whole ſpace, or medium within the ſphere of its vertue; for, otherwiſe a General, ſpeaking in the midſt of his Army, could not be heard in round. Here is the only *difference* betwixt the Actinoboliſm of Light and Sounds; that the one is performed in time *imperceptible*, though not inſtantaneous: the other in moments *diſtinguiſhable*, which are more or leſs according to the degrees of diſtance betwixt the ſonant and audient. Again, as the Deradiation of Light, conſidered meerly as *Viſible*, not as *Lucidum*, is *Conical*, or Pyramidal, in reſpect to the Eye of the Spectator; as we have profeſſedly demonſtrated in the 10. *Article of the* 1. *Sect. of our Chapt. concerning the Nature of Light*: ſo likewiſe doth every ſound make a Cone, or Pyramid in the medium, whoſe Baſe conſiſteth in the extreme of the body producing the ſound, and cone in the ear of him that hears it; or as ſome Mathematicians, as *Blancanus* and *Merſennus*, whoſe Baſe is in the Ear, and Cone in ſome one point of the ſonorous ſubject. Allowing only this Difference; that the Cones or Pyramids of Viſible Species are more *Geometrical*, *i. e.* more exactly conform to proportion Geometrical, than thoſe of Audible Species; which in regard as well of the groſsneſs of their Particles, as leſs velocity of their motion, are eaſily injured and perturbed by Winds. And this, in truth, is the beſt ground they have to ſtand upon, who opinion Sounds to be no more but ſimple *Motions* of the Aer.

Art. 5. In their certifying the ſenſe of the *Magnitude*, *Figure*, and other Qualities of their Originals.

(4) As Viſible Species, ſo do Sounds inform the Senſe, of the Magnitude, Figure, and other Qualities of the Bodies, from which they are emitted. For experience aſſureth, that Greater Bodies emit a Graver Sound, than ſmaller; that Concaves yeild a ſtronger and more laſting Sound, than Planes; that Hard things ſound more Acutely than Soft; ſtrings

ſtrings diſtended yeild a ſharper ſound, than lax; Empty veſſels than full, &c. Hence is it, that Goldſmiths, and Coyners diſtinguiſh good mony from bad, pure Gold from that largely allayed with Copper; and Metalliſts judge of ſimple and compound Metals, only by their Ring or ſound. And we have heard of Vintners, who could exactly diſtinguiſh the Kinds and Goodneſs of Wines, only by the ſound of the Veſſels that contained them: and therefore uſed to chooſe them more by their Ear, than Palate. But, what we here ſay, that *Harder Bodies emit a ſound more Acute than ſofter*; we deſire may be underſtood only of the *Plurality*, not Generality of Bodies. For the examining *Merſennus*, having experimented the different ſounds of Metalls, tells us (*in præfat. ad Harmonic.*) that He found a Cylindre of Iron to be Uniſone to another of ſteel, equal in diametre and length; and both in acuteneſs to tranſcend a Cylindre of Braſs of equal dimenſions, by a whole Diateſſaron: nay more, that a Cylindre of Firr Wood yeilded, upon equal percuſſion, a ſound more acute by a whole Ditone, than a Cylindre of Braſs, which yet yeilds a ſound more ſtrong, laſting and grateful than any of the reſt. Each of which obſervations is ſufficient to cut off the general intaile of that Canon, *Sonos eò acutiores, quò duriora fuerint corpora. Legendus eſt Athanaſ. Kircher. Art. Magn. Conſoni & Diſſoni lib.* 1. *appendice de Phonognomia.*

(5) As a Greater Light alwayes obumbrates a Leſs, ſo a Great Sound alwayes drowns a Leſs: for it is manifeſt, that the ſound of a Trumpet conjoyned to the low or ſubmiſſive voice of a man, makes it wholly unaudible, and the loud clamours of Mariners are ſcarce heard in a tempeſt. *Art. 6.* In the obſcuration of *Leſs* by *Greater.*

(6) As a too great Light offends alwayes, and often deſtroyes the ſight, as is eminently exemplified in the tyranny of *Dionyſius*, the Sicilian: ſo, too great ſounds injure and lacerate the Hearing. For, many men have been ſtrucken deaf for ever, by great Thunder-claps, and as many by the reports of grand Artillery. *Art. 7.* In their *offence* of the organs, when excesſive.

(7) As Light, meerly by the Condenſation of it rayes, produceth Heat in the aer: ſo Sounds meerly by their Multiplication. For, it is obſerved, that in all Battails, and chiefly in Naval fights, where many Cannons are frequently diſcharged, the aer becomes ſoultry and hot; not ſo much from the many ſulphureous or igneous particles of the Gunpowder commixt with, as the violent concuſſions, and almoſt continued agitation of the Aer. So that even in this particular, that Axiom, that *Motion is the Mother of Heat*, holds exactly ſound. *Art. 8.* In their production of Heat by *Multiplication.*

(8) The Effects of Audible Species, as well as of Viſible, are ſubject to variation, according to the divers Condition of the Medium. For, as Flame, beheld through ſmoak, ſeems to tremble: ſo do ſounds, trajected through aer variouſly waved by Winds, riſe and fall betwixt every Guſt; as is obſervable moſt eaſily in the ringing of Bells, whether the wind be favourable, or adverſe. *Art. 9.* In their *Variability*, according to the various diſpoſition of the *Medium.*

(9) And what moſt conduceth to our comprehenſion of the Nature of a Sound; For, as Light, ſo is a Sound capable of Locomotion, Exſilition, Impaction, Reſilition, Diſgregation, Congregation; all which are the proper *Art. 10.* In their chief Attributes, of *Locomotion, Exſilition, Impaction, Reſilition, Diſgregation, Congregation.*

and incommunicable Attributes of Corporiety. Only we must confess them discrepant in this, (1) That Sounds are delated from their Original not only in direct lines, but circular, elliptical, parabolical, and all others; for a sound heard on the other side of a high Wall, comes not to the ear in a direct line through the Wall, as *Kircherus* contends (*in Musurgiæ Universal. lib.* 1.) with tædious arguments, but in an *Arch*, as the incomparable St. *Alban* hath firmly evinced (*in Cent.* 3. *Natural. Hist.*): whereas Light constantly progress through the Medium to the Eye, in Direct lines, whether primary, reflex, or refracted. (2) A Sound is diffused through it sphere of activity in a longer space of time, by much, than Light, as is sensibly demonstrated by this, that the flash of a Cannon arrives much sooner at the Eye, than the report at the Ear: and the immediate Reason hereof is the less velocity of motion in the sound, which consisting of grosser particles than those of Light, must be proportionately slower in its Delation. For, a Sound seems to be nought but the Aer, at least the subtler or more æthereal part of aer, extrite and formed into many small (*Moleculæ*) masses, or innumerable minute Contextures, exactly consimilar in Figure, and capable of affecting the Organ of Hearing in one and the same manner: which configurated small masses of aer fly off from bodies compulsed or knockt each against other, with some violence; and progress by Diffusion in round. For, because upon pressure they mutually recede, each particle going off in that point where it finds the freest egress: therefore must some tend upward, others downward, some to the right, others to the left, some obliquely, others transversly, &c. but all more slowly than the particles of Light, whose Tenuity being far greater, causeth them not to be subject to retardment by the like tumultuous Convolution. But, as the greater Corporiety of Sounds makes them *slower* in their *Diffusion*; so doth it make them more *impetuous* and forcible in their *Impaction*, than the Species of Light: it being obvious to observation, that Violent Sounds, such as great Thunders, Volleys of Cannon shot, the breaking of Granades, &c. usually shake the largest Buildings, and shiver Glass windows at a mile distance and more. And yet are Sounds far easilier impeded, perturbed, and flatted, than the rayes of Light; every man knowing that no sound can penetrate Glass, but in one case, or exigent of Nature, of which we shall particularly speak, in the last Section of this Chapter: and since Sounds are repercussed more slowly; they are Disgregated more hardly, and Congregated more faintly, than the rayes of Light. Lastly, the Proportion of Retardation in the diffusion of Sounds to the utmost of their sphere of activity, is such even from Winds; that as *Mersennus* hath computed, the diameter of the sphere of a sound, heard against the wind, is by almost a third part less than the diameter of the sphere of the same sound, assisted by a favourable or secund Wind: but the Diameter of a Lucid Sphere is alwayes equal, which way soever and how violently soever the wind blows. (3) Bodies of narrow Dimensions make a sensible reflection of Light; as is manifest from a Burning-glass of an inch diameter: but a Body of far greater dimensions is required to the sensible Reflection of a Sound, i. e. to the production of an Eccho; though it is not to be doubted, but a sound may be reflected from every Hard bodie on which it is impinged. This considered, we cannot but smile at the Credulity of many great *Aristoteleans*, who are persuaded that an Echo is made by

by the meer Repercuſſion of the Sound from the particles of the Aer. For, notwithſtanding we deny not, but the particles of the aer, within the ſphere of the Sounds diffuſion, encountring and arietating thoſe particles of the ſound, may in ſome ſmall meaſure repercuſs them: yet we think it unſafe, therefore to admit this aereal Repercuſſion to ariſe to Senſibility, or to be obſervable by the Creation of an Echo. And therefore we conceive, that whatever ſenſible Reflection or Multiplication of a Sound, ſeems to proceed from the Aer, is not cauſed really by the Aer, but ſome Denſe and Hard Bodies, ſuch as Rocks, Ædifices, Arches, &c. whoſe Concavities reflect the particles of a Sound for the ſame reaſon, that Concaves Multiply Light.

SECT. II.

Art. 1. The *Product* of the Præmiſes, concerning the points of Conſent, & Diſſent of Audible and Viſible Species: *viz.* That Sounds are *Corporeal.*

THE *Congruities* of *Viſible* and *Audible* Species being ſo many and Eſſential, and their *Incongruities*, or points of Diſcrepancy ſo few, and thoſe altogether conſiſting in the meer Degrees of Velocity, and ſome other Circumſtances relating to the Medium: we have a fair and direct way opened to our Enquiry into the *Quiddity* or *Eſſence* of a Sound. Wherefore ſince to conclude a parity of *Eſſence*, from a parity of *Attributes* and *Effects*, in any two Entities; is warrantable even by the ſtricteſt laws of Reaſoning: we ſhall adventure to aſſume a *Sound to be a Corporeal Ens.* Which before we farther confirm by Arguments, it behoveth us to lift that block of contrary *Authority* out of our Readers way; at which the credulity and incircumſpection of many have made them ſtumble and hault ever after in their Opinions concerning this Subject.

Art. 2. An *obſtruction* of præjudice, from the generally ſuppoſed repugnant *Authorities* of ſome of the Ancients; expeded.

True it is, that *Pythagoras*, *Plato*, and *Ariſtotle*, according to the *Memorials* of *Plutarch* (4. *Placit.* 20.) unanimouſly held a Sound to be *Incorporeal*, a meer *Accident*, or *Quality*, or *Intentional Species*; contrary to the doctrine of *Democritus*, *Epicurus*, and the *Stoicks*, who, as *Laertius* (*in lib.* 7.) expreſly records, affirmed it to be *Corporeal*, or a Material Efflux, the words of *Epicurus* being [ἡ φωνὴ εἶναι ῥεῦμα ἐκπεμπόμενον ἀπὸ τῶν φωνούντων, ἢ ἐχόντων, ἢ ψοφούντων] *Vocem ſeu Sonum, fluxum eſſe emiſſum ex rebus aut loquentibus, aut ſonantibus, aut quomodocunque ſtrepitum edentibus.* But yet we conceive this repugnancy of Authority inſufficient to infirm our Theſis of the CORPORIETY of Sounds; as well becauſe ſimple Authority, though never ſo reverend, is no demonſtration, and ſcarce a good argument, in points Phyſiological, where the appeal lies only to Reaſon: as for this weighty conſideration, that *Theſe* accepted a ſound in *Concreto*, i. e. for the ſubſtance of the Aer, or its moſt tenuious particles, together with their proper Configuration; but *Thoſe* in *Abſtracto*, or only for the Figure impreſt upon the ſuperfice of the Aer, which they therefore inferred to be Incorporeal, that is, devoyd of Profundity. For, otherwiſe *Plato* (*apud Agellium*, *lib.* 5. *cap.* 15.) defines a ſound *Acris validaque aeris percuſsio*, a ſmart and ſtrong percuſſion of the aer: and *Ariſtotle* (2. *de Anim. cap.* 8.) calls it downright a *Motion of the Aer*; as the *Stoicks*,

Stoicks, *Ictus aeris*, a ſtroke of the aer. So that the Difference ſeems occaſioned only by their diverſe Acceptation of the word Sound. This obſtruction removed, we progreſs to the diſcharge of our province, *viz.* the Eviction of the Corporiety of a Sound.

Art. 3. An Argument of the *Corporiety* of Sounds.

The *First* Argument of the Corporiety of a Sound, is (*Quod vim habet agendi, ſive efficiendi aliquid*) that it is *Active* or *Effective*. For, the voice of a man violently emitted, or highly elevated by a kind of grating offends the vocal organs, and changes their ſweetneſs or evenneſs into a hoarſneſs; and being long continued, leaves them miſaffected with laſſitude: as the experience of Hunters and Orators demonſtrates.

Hither are we to referr *Lucretius* his

Præter radit enim vox fauces ſæpe, facitque,
Aſperiora foras gradiens arteria clamor, &c.

Art. 4. A *Second* Argument.

The *Second* is deſumed from its Capacity of *Repercuſſion*, or Reſilition from ſolid bodies; which is the evident cauſe of our hearing one ſound twice, or more often, according to the multiplicity of its Reflections: as in all *Echoes*, monophone or polyphone. Which *Ariſtotle* fitly compares not only to a *Ball* frequently rebounding, but alſo to *Light*, which Himſelf confeſſeth capable of reflections even to infinity: thereon concluding a ſound ſubject to the ſame laws of Reflection with either. To which *Virgil* ſeems to allude in his

Saxa ſonant, vociſque offenſa reſultat Imago.

Intimating, that an Echo holds a perfect analogy with an Image reflected from a Mirrour. For, as beſide that Image, which tends in a direct line from the Glaſs to the eye, innumerable others are ſo transferred from it into all points of the Medium, that divers other eyes variouſly poſited therein ſhall behold the ſame general Image, each one receiving a particular Image: ſo likewiſe, beſide that ſound or voice, which arrives at your ear, innumerable others are ſo diſperſed through all parts of the medium or ſphere of diffuſion, that if there were as many ears therein as the ſpace could contain, each one would hear the ſame general ſound or voice; and if it chance that any one particular voice be impinged againſt ſolid and lævigated or ſmooth bodies (for ſolids that are very Spungy or porous, ſuffer ſounds to paſs through them, and too ſcabrous or rough deſtroy them by diſſipation) it may be repulſed in a direct line toward your ear; and you ſhall hear it again at ſecond hand or Echoed.

COROLLARY. *Art.* 5. The Cauſes of *Concurrent Echoes*, where the Audient is equally (almoſt) diſtant from the Sonant and Repercutient.

Touching the *Reflection* of Sounds, we ſhall here, by way of *Corollary*, briefly obſerve. That in caſe you ſtand ſomewhat near to the ſmooth ſolid that reflecteth the ſound, and the Creation of the ſound be not very remote; then though an Echo thereof be made, yet ſhall not you hear it: becauſe the *Direct* ſound and the *Reflex* enter the ear ſo continently, i. e. the ſpace of time betwixt their ingreſs is ſo imperceptible, that they ſeem but one intire ſound. But, in this caſe, the ſound becomes both ſtronger and longer; in reſpect of their Union.

And

And this comes to paſs chiefly, when the Reflection is made from divers bodies at once; as in all Arches, and Concamerated or vaulted rooms: in which for the moſt part, the ſound or voyce loſeth its Diſtinctneſs, and degenerates into a kind of long confuſed Bombe.

COROLLARY. 2. *Art.6.* Why *Concaves* yeild the ſtrongeſt and longeſt Sounds.

And hence, *viz.* the many Repercuſſions of a Sound from divers places together, or with ſo ſhort intervals of time, as the ſenſe cannot diſtinguiſh them; is it, that the ſound of *Concaves* percuſſed, laſteth much longer, than the ſounds of bodies of any other figure whatever: eſpecially when the Concave hangs at liberty, in the aer, ſo that its Tremulation be not hindred as are all Bells in Churches, and clocks. For, not only the External or ambient aer, but the Internal is agitated by thoſe frequent Tremblings in the body of the Concave, and continuedly repercuſſed from ſide to ſide: and therefore, till the trembling ceaſeth, the Bombination is continued.

COROLLARY 3. *Art.7.* The reaſon of *Concurrent Echoes*, where the Audient is near the Reflectent, and remote from the ſonant.

Again, if you ſtand far from the ſonant bodie, and near to the Reflectent; in this caſe alſo will the ſound appear ſingle, and coming only from the Reflectent: becauſe both the Direct and Reflex ſound invade the ear without any ſenſible difference in time; and yet the Reflex ſound as it is really the poſterior, ſo doth it very much intend or increaſe the Direct, and conſequently makes the impreſſion obſervable only from it ſelf.

COROLLARY 4. *Art.8.* Why *Echoes Monophon* rehearſe ſo much the fewer ſyllables, by how much nearer the audient is to the Reflectent.

It is obſervable moreover, that by how much nearer the Ear is to the Anacamptick, or Reflectent (yet at ſuch diſtance, as is required to the diſcernment of the Direct voyce from the Reflex.) by ſo much the fewer ſyllables of a word pronounced are Echoed: and *è contra*, by how much farther from the Reflectent (provided the diſtance exceed not the ſphere of diffuſion) ſo many more ſyllables are repeated. The Reaſon being this, that the interval of time betwixt the Ceſſation of the Speaker, and the audition of the Reflex voice, is much leſs in the firſt caſe, and much greater in the later: and conſequently, the leſs interval of time ſufficeth to the Diſtinction of a fewer ſyllables, and the greater for more. This conſidered, we can no longer admire the diſtinct rehearſal of a whole Hexameter by ſome ſtrong Echoes; provided the voice pronouncing the verſe be ſufficiently ſtrong to drive it to the Reflectent, and thence back again to the Ear, at large diſtance, ſuch as is neceſſary to the allowance of time enough for the ſucceſſive repercuſſion of each ſyllable: for otherwiſe the voice faileth by the way.

COROLLARY 5. *Art. 9.* The reaſon of *Polyphon* Echoes.

What hath been hitherto ſaid, concerns only Echoes *Monophone*, that repeat the ſame ſyllable but once; but there are Echoes *Polyphone*, ſuch as repeat one and the ſame note, or ſyllable divers times over, and of them the Reaſon is far otherwiſe. For, the frequent rehearſal of the ſame ſyllable by an Echo, ariſeth from the multitude of Reflectent Bodies, ſituate beyond each other in ſuch order, that the nearer bodies referr it firſt, and the remoter ſucceſſively: and ſometimes from Bodies mutually Confronting each other, and alternately reflecting the ſame ſound. Of this ſort were thoſe obſerved by *Lucretius*, in this Triſtich.

Sex etiam, aut ſeptem loca vidi reddere voces,
Unam cum jaceres; ita colles collibus ipſis
Verba repulſantes, iterabant dicta referre.

Such

Such alſo was that prodigious one that entertained the Curioſity of *Gaſſendus* at *Pont Charenton* ſtanding upon the river Seine, four miles from *Paris*. For in a ſquare old ædifice of free-ſtone, uncovered at the top, and having a row of 5 Pillars on each ſide, as commonly our Churches, He heard a Monoſyllable, which himſelf pronounced, clearly and orderly repeated by ſeveral Echoes, 17 times over; and when he uttered the Monoſyllable in the Centre of the Ædifice, it was brought back to his ear 17 times from each extream (the area being ſomewhat oblong) ſo diſtinctly, as He could eaſily numerate the repetitions on his fingers. If ſo *ſileat Miracula Memphis*, let the *Ægyptian Pyramids* no longer boaſt their *Pentaphone* Echoes; nor the *Porticus Olympiæ* challenge the garland from the world for her *Heptaphone* Reſonance, which is highly celebrated by the pens of *Plutarch* (*lib.4. de placit. Philoſoph. cap.* 20.) and *Pliny*, (*lib.* 36. *cap.* 15.). For, this at *Pont Charenton*, of which our Lord *St. Alban* was alſo an ear-witneſs, and not without ſome admiration, as Himſelf hath recorded (*in Centur.* 3. *Nat. Hiſt.*) hath no Rival, but that many tongued Echo in a Village called *Simoneta*, near *Millan* in *Italy*, which at ſome ſeaſons, when the aer is ſerene, will iterate any Monoſyllable, in which is no S. (which being but a kind of ſibilation, or interior ſound, few or no Echoes can reherſe) 30 times over very diſtinctly; if credit be due to the teſtimony of *Blancanus* (*in Echometria, & in ſuo additione ad theorem.* 20. *de Echo polyphona.*)

Art. 10. A *Third* Argument of the *Materiality* of Sounds:

A *Third* Argument of the materiality of a Sound, reſults to us from the *Pleaſure* and *Offence*, or *Gratefulneſs* and *Ingratefulneſs* of Sounds, as they are Concinnous, or Inconcinnous. For it is highly concordant to truth, that the ſuavity of a Sound proceeds from hence, that thoſe minute Particles, which enter the ear and move the Auditory Nerve, are in their configuration ſo accommodate to the Receptaries, or Pores thereof, that they make a gentle, ſmooth or equal impreſſion on the filaments, of which the Acouſtick Nerve conſiſteth: and on the contrary, the Acerbity, or Harſhneſs of a Sound, only from hence, that the minute particles invading the ſenſory, being aſper or rough in their configuration, in a manner exulcerate, grate, or dilacerate the ſlender Filaments thereof.

Art. 11. The neceſſity of a certain *Configuration* in a Sound; inferred from the Diſtinction of one ſound from another, by the Senſe.

That a certain *Configuration* of its minute particles, is eſſentially neceſſary to every Sound, may be concluded ſafely even from hence; that ſo great variety of Sounds, and chiefly of Words, or Letters, as well Vowels as Conſonants, could not be ſo exactly diſtinguiſhed by the Hearing, unleſs the ſenſory were variouſly, or in a peculiar manner percelled and affected by each: nor can that variety of *Affection* be made out, but by a variety of *Sigillation*, or Impreſſion, dependent reſpectively on the various *Configuration* of thoſe (*moleculæ*) ſmall maſſes, that compoſe the ſound.

Art. 12. The ſame confirmed by the Auctority of *Pythagoras*, *Plato*, and *Ariſtotle*.

To ſweeten the harſhneſs of this Aſſertion yet more; we alledge the uniſon Auctority of no leſs than *Pythagoras* (whom all knowing men allow to have lighted the tapour to poſterity, in the inveſtigation of the Nature, and cauſes of proportions among Muſical Sounds) *Plato* and *Ariſtotle*, all which affirmed the ſame, if *Plutarch* be faithful (*in* 4. *de placit.*) while He introduceth them ſaying, τὸ σχῆμα, *Figuram, quæ in aere, ejuſque ſuperficie fit certo ex ictu* (τὴν ποιὰν πλῆξιν) *evadere vocem,*

vocem, that the Figure made in the aer, and then it superfice, by some certain percussion, becomes a voice. And, that *Plutarch* hath done no more than justice to *Aristotle*, in this particular; is evident from his own words, (*in Problem.* 13. & 51.) where He expresly enquires, *Quare Vox, cum sit* "Αηρ τὶς ἐ̓χηματισμένος, *Aer quidam Figuratus*, *& qui dum transfertur, plerumque,* τὸ σχῆμα, *Figurum amittit, illam tamen dum a solido corpore repercutitur, incolumem servet?* "Why a voice, which is aer con-"figurate, and for the most part loseth its Figure, in its [long] transmissi-"on, doth yet conserve it intire and unimpaired, when repercussed from a "solid body, as in all Echoes?

Art. 13. And by the *Capacity* of the most subtle parts of the Aer.

Nor can it be rightly denied, but that Flux of minute aereal Bodies, or most æthereal parts of the aer, which are excussed in round by two bodies arietating, are easily *Capable of Configuration*: when as much is subindicated even by those sensible Vortices, or Whirlings and Eddies of Winds, which are frequent in summer. Under this title fall those words of *Epicurus*, τοῦτο δὲ ῥεῦμα εἰς ὁμοιοσχήμονα θρύπτεσθαι θραύσματα, &c. *Hunc vero fluxum in frustula consimilis Figuræ comminui:* the full sense whereof seems to be this. That whem a Voyce is emitted from the mouth, or other sound from what body soever; the Contexture of the minute bodies effluent is so compreſt, and confracted into smaller contextures, that of the Original are made swarms of Copies, or lesser masses exactly consimular in their Formation: and that those are instantly dispersed sphærically, or in round through the whole circumfused space, still conserving their similitude to the Original, or General voyce, or sound, till their arrival at the Eare; and so retaining the determinate signature of their Formation, are distinguisht accordingly by the sensory. By this it appears, that *Epicurus*, in this point, dissented inconciliably from *Democritus*; who conceived that all sounds were delated to the Ear by *Propagation*, i. e. that the sound being broken into myriads of small Fragments, each fragment did form the contiguous Aer into Contextures of the same Configuration with the Prototype, and those again formed the particles of aer next adjacent into the like, and so successively through all parts of the medium till they came home to the Organ of Hearing; not much unlike the dream of the *Aristoteleans*, concerning the Propagation of the species of Light in each point of the medium. Whereas the Conception of *Epicurus* is this, that the Primitive Configuration of the most tenuious particles of the Aer, by the percussion or Collision, is broken into many small masses; and each of those, at farther remove from the sonant into many smaller, and those again into smaller, all exactly respondent to the First in figure: after the same manner, as we observe a spark of Fire exsilient from a Firebrand, to be broken into a multitude of less sparks, and each of those shivered again into many less, until their exility makes them totally disappear.

Art. 14. The Reason and manner of the *Diffusion* of Sounds, explicated by a congruous *Simile*.

This Reason and manner of the Diffusion of a Sound throughout so great a space of the medium, They may easily comprehend, who have observed the Sewers of Princes in *Italy* spout Orang-flower water, or other Fragrant Liquors, out of their mouths, with such dextrous violence, as to disperse it in a kinde of mist, through the aer of a spacious room, so that the aer contained therein becomes impregnate with the Odour; for the more noble entertainment of the sense. For the

Consent betwixt this *Exsufflation* of Water, and the spherical Diffusion of a Sound, is very manifest, the greater Drops of water being in their trajection through the aer, broken, by reason of the impulse of the breath, that discharged them in distress, into swarms of less drops, and those again into less, successively in the several degrees of remove, until they attain such exiguity, as we observe in the particles of a mist: and that small proportion of Aer, emitted from the mouth of him that speaks, being disperied into a dense mist of voyces, replenishing the whole sphere of Diffusion.

Art. 15. The most *subtle Particles* of the Aer onely, the *material* of Sounds.

Here we are constrained to a cautionary advertisement; that when we say, the *Aer is the Material of all voyces*, we do not mean all the Breath expired from the Lungs, together with those Fuliginous Exhalations, that the Densation of the aer, in Cold weather, subjects to the discernment of our sight; but onely the most *subtle part of the Aer* inspired, and modulated in the Vocal Artery and other organs of speech: because such onely can be judged capable of Configuration. Nor can so small a quantity of purest Aer be thought insufficient upon Dispersion to possess so capacious a sphere, as that of every ordinary voice; so that of a whole Theatre of Auditors, each one shall distinctly hear it: insomuch as onely a mouthful of Water blown from a Fullers mouth, is so diffused as to irrigate the aer replenishing a room of considerable amplitude. Especially, when the Analogy holds quite through. For, as the Drops of Water are so much both larger and denser, by how much neerer they are after exsufflation to the mouth of the Fuller: so also are the Vocal masses of aer so much more large and dense or agminous, by how much neerer they are to the mouth of the Speaker; and *è contra*. Which alone is the reason, why the Voyce of an Orator in a Theatre is more strong and distinct to those of his Auditory, that sit neer at hand, than to those far off; provided the place afford no *Concurrent Eccho*, for in that case, the Reflex voyce entering the eare united with the Direct or Original, magnifies the impression on the sensory.

PARADOX. *Art.* 16. One and the same numerical voyce, not heard by two men, nor both ears of one man.

Now, insomuch as it is consentaneous to right reason, to conceive, that the Voice at its first Emission from the mouth, its one General Configuration of the most tenuious particles of the Aer, with some vehemency efflated from the vocal organs, after frequent collisions and tremulous repercussions, and that this General voice, in its diffusion through the medium, is contracted and dispersed into myriads of minute vocal configurations or Particular voyces, some of which invade the ears of one person, others of another, &c. Hence is it a clear, though perhaps new and very paradoxical, truth, *That the same numerical voyce of an Orator, is not heard by any two of his Auditors, nay not by the 2 ears of any one; but every man, and every Eare is affected with a distinct voyce.* And yet he incurrs no Contradiction, that affirms the whole Auditory to receive the same voyce. For, as all the water exsufflated into a mist from the mouth of an Italian Sewer, or common Fuller, may be said to be one and the same Water; though all the minute Drops, diffused into several parts of the aer, and irrigating the several parts of the Floor or cloth, on which they are rained down, be not the same drops: so likewise may we allow all the Aer efflated from the mouth of the speaker, to be one and the same Aer; though the Particular Voyces, delated to particular

Ears

Ears, are not the same Numerically. Besides; should we, with the major part of Scholers, admit a voice to be an Entity meerly *Intentional*, or simple *Quality*, or *Accident*, yet should we not detract one grain of weight from this our *Paradox*: since, to conceive any one Particular voice to be in divers places, or subjects, at once, is manifestly absurd.

Art. 17. *A PROBLEM* not yet solved by any Philosopher: *viz.* How such infinite Variety of Words is formed onely by the various motions of the *Tongue* and *Lips*.

Here opportunity would prompt us to insist upon the admirable *Conformation* of an *Articulate* Sound, and to enquire how each Vowel and Consonant is created by such and such motions of the Vocal Instruments: but the exceeding Difficulty countermands that inclination. For, though *Casserius*, *Placentinus*, (*in Anatom Sirmorin. Organ.*) & *Athanasius Kircherus* (*in lib. Anatomico de natura Sonis & Vocis, à cap.* 10. *ad finem libri.*) have attempted laudably in that abstruse theme: yet the Audit of their discoveries riseth no higher than this single rule, That the Vocal Artery and Lungs onely conduce to the Acuteness and Gravity of the Voice; as they discharge the inspired aer more Presly, or Laxly; and *Kircher* (*in cap.*10.) ingenuously confesseth, *At quomodo voces in gutture formentur, qua proportione elisionis aeris nascantur, tam obscurum est, quam voces hujusmodiclaræ sunt & manifestæ auditui.* The difficulty, indeed, seems to consist chiefly in this, *How from the various motions of one single Organ, the Tongue* (the Author of Distinction in all Articulate sounds, though the Palate, Epiglottis, Uvula and Teeth are in their respective degrees of assistance inservient to the Elision of aer made by the Tongue) *and that two-leafd Door of the mouth; the Lips, such infinite variety of Letters and words doth most easily and almost insensibly result.* To solve this, the General answer is, that the wonder ought to be no greater, how one Tongue can suffice to the Articulation or Distinction of innumerable words, by its various Motions; than that, how one Hand sufficeth to the Distinction of innumerable Characters. But, the Motions of the Hand requisite to Distinction of every Character, are observable by the sense: and those of the Tongue and Lipps requisite to the Formation of every word, together with the proportion of the Aers Elision in every Articulation, is deeply obscure: and therefore the Disparity being manifest, the *Problem* remains untoucht; and our Admiration not so much as palliated.

Art. 18. A Second (also yet unconquered) *Difficulty*, viz. the determinate *Pernicity* of the Aers motion, when exploded from the Lungs, in Speech.

This Place might also admit another *Considerable*, as terrible to the most daring Curiosity as the Former; and that is the *ineffable Pernicity*, whereby the Aer is exploded from the Lungs, that so it may attain the Form of a voice. For, to the Creation of a voice Consonous, or Unison to the sound of some one string on a Lute; it is necessary, that the Aer be exploded by the Lungs, with the same Pernicity, as the other Aer is impelled by the string in each of its most rapid Vibrations, or alternate Recurses, after its smart percussion by the finger, or plectrum. But this Arcanum requires a *Galilæo* or *Mersennus*, at least, to its due speculation.

Art. 19. All sounds Created by *Motion*, and that either when that intermediate Aer is confracted by two solids, mutually resistent; or when the aer is percust by one Solid; or when a solid is percust by the Aer.

The *Observable* most proportionate to our Capacity, and Competent to our præsent Designation, is this; *That no Sound is created without Motion*: and consequently, that the Thing Sonant, being endowed with solidity in some degree or Compactness sufficient to Resistence, ought either to be strook against another, that is solid and resistent; as when a Hammer is strook upon an Anvil; or against the Aer, in Flux and not much resisting, and that either by Pulsation of the Aer by a solid, as when the string of

Lute percusseth the aer; or the Pulse of the solid by the Aer, violently agitated, as in all Pneumatick, or Wind instruments, where the stroke of the aer against the sides of the Concave causeth the Sound.

Art. 20. *Rapidity* of motion necessary to the Creation of a Sound, not in the *First* Case.

In the *Former instance*, it is not necessary to the Creation of a Sound, that the Collision be made by a motion rapid; because the Resistence, on either part equal, causeth that when the Access or Appropinquation of one Solid to the other is Continent, the Aer interposed is Continently impelled and repelled reciprocally: and as the Aer becomes the more hardly distrest on each part, by how much neerer the two Solids approach each other; so proportionately is the motion more rapid. So that, by that time the two solids touch each other superficially, the motion is encreased to the highest rapidity, and the distrest Aer, no longer able to endure Compression, or to go and come alternately between the Solids, now contingent, breaks forth laterally in round, and is diffused in shivers through all parts of the medium, so that arriving at the Ear, it puts on the species of a Sound.

Art. 21. But, in the *Second* and *Last*;

But, in the *Second* and *Third* instances, it is necessary the motion of Collision be far more rapid, in order to the Creation of a Sound: because the Resistence, which is wanting on the part of the Aer, must be compensated by the frequent pulses and repulses of it, as when the Chord of an Instrument percust, doth very frequently impel the aer, by its Vibrations (the Greeks call them, χραδασμοὶ) or Reciprocations; or, as in Wind instruments, where the inflated Aer is, by quick reverberations from the sides of the Concave, very often impulst and repulst.

Art. 22. That all Sounds are of *equal Velocity* in the *Delation*.

As for the Motion of the Aer, after its Formation into a Sound, from the Sonant to the Ear, therein is one particular worthy the wonder even of Scholars: and that is, *Whatever be the vehemence or remissness of the Collision, or force, by which the Aer is exagitated, yet is the Translation of the Sound, thence resulting, through the intermediate space to the term of it sphære, always equally swift.* For Experience demonstrates, that all Sounds small and great, excited in one and the same place, though they differ much. In the extent of their sphears of Audibility, are delated to that place in which they are heard, in equal time. This is easily observable in the reports of a Cannon and a Musquet, successively discharged at a mile distance. For, standing on a Tower, or other eminent place, and noting the moment, first when the Cannon is fired (the report and Flash being made both at the same instant) and numbring how many Pulses of your artery, or how many Seconds in a Watch denoting them, intercede betwixt your sight of the flame, and hearing the report, and then accounting how many Pulses, or Seconds intervene betwixt the flash and report of a Musquet: you shall finde the number of these equal to the number of those.

Art. 23. The Reason thereof.

The *Reason* of this Æquivelocity of unequal Sounds, the *Stoicks* (*apud Plutarch.* 4. *placit.* 19. *& Laertium lib.* 7.) well insinuate, while they affirm, that the Aer percussed, in regard of its Continuity, is formed into many Rounds, such as those successively rising and moving on the surface of Water, upon striking or throwing a stone into it; which Circles made on the surface of Water by a small stone, move in the same tenor, and successively arrive at the margin of the River, or Pool,

Pool, in as ſmall time, as thoſe cauſed by a great ſtone. And *Ariſtotle* (2. *de Anim. cap.* 8.) expreſly declares his judgement, that the reaſon of the Delation of a Sound from the Sonant to the Audient, is the Continuity of the Aer: though *Simplicius* and *Alexander* differently interpret that Text, the one conceiving that he meant that a Sound was tranſlated through the medium by reaſon of *ſympathy* among the parts thereof; the other, by *Propagation* of the like Sound in all points of the medium ſucceſſively, after the manner of ſpecies Viſible, according to the dream of *Ariſtotle.* But all one it is to us, whether we conceive the motion of a Sound made by Propagation, or Undulous Promotion; as to our præſent ſcope: ſince either ſufficeth to explicate the Cauſe, Why a Sound is longer before it arrive at the Eare, than a Viſible ſpecies before it arrive at the Eye; becauſe the Viſible ſpecies is tranſmitted from the Object, neither by Propagation, nor Undulation, but Directly, and therefore is capable of no Retardment from the Medium.

Art. 24. To meaſure the Velocity of great Sounds.

As for the definite Velocity of Sounds, or determinate ſpace of time, in which all Sounds are delated to the Extremes of their ſpheres; we conceive it to be *Rhodus* and *Saltus*, in the General, inaſſignable: in regard of the vaſt diſparity in their ſeveral Extents, ſome ſounds being ſcarce audible at the diſtance of 20 yards, and others cleer and diſtinct at as many, nay twice as many miles diſtance. But, if we aſſume this or that determinate Sound, and attain the præciſe diametre of its ſphere; it is no difficulty to commenſurate its Velocity. For, *Merſennus* (*in reflexion. plyſicomath. cap.* 14. *& Propoſit.* 39. *Balliſtica*) upon exact Experiment, found the Fragor of ſeveral Cannons diſcharge in the Court of the Baſtile at *Paris*, to arrive at his eare, after the flaſhes, at ſuch a rate, that the ſound pervaded 233⅓. Fathoms (each containing ſix feet *Paris* meaſure) in the ſpace of every Second, or Sixtieth part of a minute: and thereupon rightly concluded, that the Report of a Cannon flyeth at the conſtant rate of neer upon 14000 Fathoms every minute, until it attain the extremes of it ſphere. If this expedient for the meaſure of the Time wherein Sound is delated, ſeem either too coſtly or laborious; you have another moſt cheap and eaſie præſcribed by the Lord *St. Alban* (*in Cent.* 3. *Nat. Hiſt.*) which is this. Let one man ſtand in a ſteeple, having a lighted taper with him, and ſome vail put before the flame thereof; and another, confæderate in the tryal, ſtand a mile off in the open field: then let him in the ſteeple ſtrike the Bell with a weighty hammer, and in the ſame inſtant withdraw the vail; and ſo let him in the field account by his pulſe what diſtance of time intervenes betwixt his ſight of the Light, and hearing of the Sound. If the ſtrokes of the Artery, which are ſubject to variation, for many cauſes, ſeem leſs certain; the Seconds in a minute watch (which are ἰσόχρονοι, æquitemporaneous) will be an exact meaſure of the interval, and ſo of the velocity of a Sound. *Plura vid. apud Merſennum lib.* 2. *Harmonic. propoſit.* 40.

Art. 25. Sounds, not ſubject to *Retardation*, from *adverſe*; nor *Acceleration*, from *Secund* Winds.

Another admirable ſecret there is in the Motion of Sound, which is, that no Winde can accelerate, or retard it, but it is delated from the Sonant to the Audient in equal time, whether the wind be high or gentle, ſecund or adverſe. For, a Secund or favourable Wind is incomparably ſlower in motion than a ſound, as appears by the Rack or drift of clouds, the undulation of Corn fields, the ſucceſſive inclination of the topsof trees in woods, the

the rowling of waves at sea, &c. but an Adverse wind, though it may indeed disturb a sound, or weaken it by suppressing some of its particles (which is evident from hence, that all sounds attaining the eare against the wind, are not so clear and distinct, as when they are heard with the wind; as in Bells, whose noyse alternately riseth and falleth in contrary gusts) yet do all the particles that remain uninterrupted, permeate the medium with equal velocity. This may be soon Experimented either by Cannons, as *Mersennus*, or a candle and bell, as the Lord *Bacon*.

SECT. III.

Art. 1. That all Sounds, where the Aer is percussed by one solid, are created immediately by the *Frequency*, not the Velocity of motion; demonstrated.

THe Præmises duly considered, it can seem no Paradox, *That a Sound is created in the Aer, not so much by the Velocity, as CREBRITY of motion:* and no unnatural Consequence thereupon, that the *Difference of an Acute and Grave Sound ariseth not from the greater and less swiftness or rapidity of the motion*, as *Aristotle* and most of his *Sectators* imagined; but *from the Frequency and Infrequency thereof, as Galilæo, Mersennus*, and *Gassendus*.

To secure this by plain *Demonstration*, take a Lute string in your hand, and having fastened one end thereof to some hook or pin in a wall, distend it gently; and then percussing it with your finger, you may perceive the Vibrations, or accurses and recurses alternately succeeding, but you shall hear no sound resulting from it: because, as every vibration of the string is performed in perceptible time, so doth the aer thereby percussed arrive at the eare with such sensible intervals betwixt each appulse, as that it leaves no impression therein remaining, which is not expunged and consolidated before the invasion of a second appulse. Then stretch the string somewhat streighter, so that the Vibrations thereof may become inobservable by the eye, in respect of their Frequency; and you shall hear a certain dull stridor, or kind of sibilation; because the Appulses of the aer, percussed by each Vibration, at the eare, will be almost Continent, so that the time interjected betwixt each stroke on the eare becomes imperceptible, and indistinguishable, nor can the first impression on the sensory be consolidated before a second renew it, &c. This done and observed, encrease the distension of the string yet more, and percussing it you shall perceive a clear sound to arise; because as the Vibrations, so are the percussions of the aer, and their Appulses to the Eare far more Continent, or more one, in regard the moments of Time intercedent betwixt the successive strokes, are more short and imperceptible.

Art. 2. And likewise, where the Aer is the Percutient:

And what we here say of the reason of a Sound resulting from a Lute-string, the same, in proportion, is to be conceived of all other Sounds created in Wind instruments, where the Aer is the Percutient. For, the breath easily and gently inflated into a Flute, Cornet, Trumpet, &c. yields no sound at all; onely because the pulses and repulses of the aer from the sides of the Concave are so infrequent, as to have the intervals of time distinguishable: and the aer likewise slowly emitted from the Lungs (the great Exemplar to all Pneumaticks) makes no voice, onely because it is not frequently

quently enough reverberated from the ſides and annulary cartilages of the Vocal Artery, and conſequently the Appulſes of it to the eare being proportionately infrequent, cannot, by their Coition or Union into one ſtronger Appulſe, make any ſenſible impreſſion on the ſenſory. But the Aer then becomes ſonant, when it is efflated with vehemency, in reſpect of its more frequent Appulſes to the ſenſory, reſpondent to the more itterated pulſes and repulſes, or reverberations of the ſides of the Vocal Artery. Thus alſo, when you draw your finger gently along a Table, or put a Hammer on an Anvil eaſily, you ſhall hear no ſound; becauſe the Repercuſſions of the Aer cauſed by that gentle motion, are ſo far aſunder in time, as never to become Continent, or Conjoyned: and conſequently, the Appulſes of the percuſſions to the eare being alike infrequent, can never make a ſenſible impreſſion on the Acouſtick Nerve. And this we conceive more than ſufficient evidence of the Verity of the Firſt part of our Theſis; That a Sound is not generated in the Aer by the Velocity, but Crebrity of motion: unleſs in a remote dependence, as Velocity is the Cauſe of Crebrity.

Art. 3. That all *Acute* ſounds ariſe from the *more*, and *Grave* from the *leſs* Frequent percuſſions of the aer, demonſtrated.

As for the Remainder, viz. *That an Acute ſound ariſeth from more frequent, and a Grave Sound from leſs frequent percuſsions of the Aer*: the Certitude hereof may be eaſily concluded from this Experiment. Faſten a long Lute-ſtring at one extreme on a hook nayled to a wall, and ſuſpend a ſmall weight at the other; then ſtrike the ſtring at convenient diſtance above the weight: and you ſhall obſerve the Swings, or Vibrations of it to be ſo ſlow, as that you may meaſure the time of each, by the ſyſtole and diaſtole of your Pulſe, or the Seconds in a Minute Watch. Then wind up the Chord exactly to the half, the ſame weight continuing appended, and percuſs it, as before: and you ſhall finde the Vibrations of it to be doubly ſwifter than the former, ſo that one Vibration ſhall be in time reſpondent to two Pulſes. Again, abbreviate the Chord to half, and having percuſſed or abduced that half, which is now but a fourth part of the whole; you ſhall obſerve the Vibrations to be again doubled in Frequency, in reſpect of the Second, and quadrupled in reſpect of the Firſt; ſo that now 4 Reciprocations ſhall be iſochronical to one pulſe. This effected, continue this determinate abbreviation of the Chord, by ſubdividing it into halfs ſucceſſively, until the Reciprocations become ſo ſwift and frequent, as to be indiſtinguiſhable by the ſenſe (though ſtill you deprehend their Velocity and Crebrity to be encreaſed at a certain rate, i. e. duplicated upon each Dimidiation of the chord) when the Aer is ſo frequently percuſſed by it, as that it becomes Sonorous, or actually ſonant. Then again Dimidiate the ſonant remainder of the Chord, and upon percuſſion you ſhall obſerve the ſound thereof to be more Acute by a whole *Octave*, than the Former: and thence you cannot but concede, that the Acuteneſs of this half of the ſonant chord, above that of the whole ſonant chord, is cauſed only by the doubly more frequent Percuſſions of the Aer, and proportionate ſtrokes of the Senſory. And, becauſe a Quadruplicate weight produceth the ſame Effect, being appended to the whole of the ſonorous chord, as a ſimple weight doth in the half, as to the Duplication of the Celerity and Frequency of the Vibrations, in the ſame moments: hence is it, that if you encreaſe the weight, retaining the ſame Longitude of the Chord, by degrees, until you advance the ſound thereof to an *Eighth*; it is manifeſt, that the Reciprocations of it are ſtill doubly more ſwift and frequent, than thoſe cauſed by the former weight. Moreover, what we affirm concerning the Half of the ſonorous Chord,

Chord, in respect of an Octave; holds true, in proportion also of the 2 thirdparts of the Chord, in respect of a *Fifth*, of the Dodrantal, or 3 quarters, in respect of a *Fourth*, and so of the rest of the musical Notes.

For, in a very long Chord, if you stop upon the third part of the half thereof, and percuss the Bessal, ot two thirds of the half remaining at liberty: the proportion of its Reciprocations will not be Duple, but sesquiasteral in respect to those of the whole length; i. e. 2 Vibrations of the Chord will not respond in time to one pulse of the Artery, nor 4. to 2. but 3. to 2. And, if you stop on the fourth part; then will the Reciprocations of the remainder be in proportion sesquitertial, i. e. 4 Vibrations shall be isochronical to 3 pulses. According to the same method, if you stop on the 5th. part of the Chord; the proportion of its Vibrations, to that of the former, will be sesquiquartal: if the 6th part, sesquiquintal; and so consequently of all other Notes. So that it seems easily determinable, by this scale, What is the proportion of the strokes inflicted on the Eare in every Acute sound, comparatively to those inflicted by every Grave: and this not onely in the sounds of a string, but all others of the like Original. To instance; when a Boy sings with a Man, and emits a note more Acute by an Eighth; it is to be conceived, that the Aer efflated from the Vocal Artery of the Boy, is doubly swifter in its motion, or doubly more frequent in its reverberations from the sides of the Wind-pipe, in respect of the double narrowness thereof, than that expired from the Vocal Artery of the man. And, hence we may occasionally advertise, that by how much the more Acutely any man would sing; by so much more streightly or narrowly must he Compress his Wind-pipe: that so the Aer may issue forth more distrest and streightned, having suffered the more Frequent reverberations from the sides and rings of the same.

Art. 4. The *suavity* of musical *Consonances*, deduced from the more frequent; and *Insuavity* of *Dissonances* from the less frequent Union of the Vibrations of strings, in their Termes.

And this is that noble Fountain from which many of our modern *Theorical Musicians* have drawn the Reason of the *Suavity* of their CONSONANCES, and *Acerbity* or ingratefulness of their DISSONANCES: and that not without mature consideration. For, when two Sounds, synchronical in their creation, arrive at the eare in the same instant, and affect it with pleasure, or a kinde of sweetness; the Cause of that sweetness can be no other but this, that the percussions of the Aer generating those two Sounds, become so united, as to leave no sensible discrepancy, that might grate or exasperate the tender sensory: and on the other side, the reason of the Discord or Insuavity of two sounds, at once emitted, is onely this; that they are not united, so that the eare deprehends and dislikes their Discrepancy. Again, the several Degrees of this Suavity and Insuavity among musical sounds, cannot be deduced with equal probability from any other original, as from the variety of Coition, and Discrepancy of the Percussions creating the Sounds. To exemplifie in the Sounds resulting from strings; take two strings, equal in their materials, length, and thickness, and distended with equal weights, or force; and when you percuss them with one stroke, they will emit equal sounds, or that Consonance, which is called an *Unison*: which will be therefore grateful, because as the Vibrations of the strings, so will the strokes inflicted on the sensory, have the same proportion each to other, as one hath to one (the proportion of Equality) and consequently will be equal in number and time, so

ſo as to affect the ſenſory moſt equally and Unitedly. But if you abbreviate one of the ſtrings exactly to half; becauſe (according to the præmiſes) the ſounds reſulting from them, at once percuſt, muſt make an *Eighth*, or that Conſonance, which the Greeks name δι' πασῶν, and we a *Diapaſon*: therefore muſt that Eighth be eminently grateful alſo; inſomuch as though after the Coalition of two ſtrokes, one reſulting from the ſhorter ſtring be inſociate, yet doth the immediately conſequent ſtroke thereof perfectly unite with that of the longer ſtring, and ſo the Unition is made Alternately, or at every other ſtroke; and therefore doth this Conſonance invade the ſenſe of all others, an Uniſon only excepted, moſt unitedly and equally, and conſequently is the moſt pleaſant and charming of all Conſonances, after an Uniſon. And when you make the proportion of the ſhort ſtring exactly Sequialteral to that of the long; becauſe the ſounds reſulting from them, both at once percuſſed, make a *Fifth*, or *Diapente*: therefore will that Conſonance alſo have a conſiderable degree of ſweetneſs, though ſhort of that of an Eight; inſomuch as though two ſtrokes paſs inſociated, yet doth the Union follow in every Third, and ſo the Unition is ſufficiently frequent to pleaſe the ſenſe, which is beſt delighted with that object, in which is the leaſt difference of parts, according to that *fourth Præcogn. of Des Cartes* (*in compend. Muſicæ, pag. 6.*) *Illud objectum facilius ſenſu percipitur, in quo eſt minor differentia partium.* Again, if you make the proportion of the ſhort ſtring Seſquitertial to that of the long; becauſe a Fourth, or Diateſſaron, doth reſult from the percuſſion of them together, therefore will that Conſonance be likewiſe competently grateful: in reſpect that after three inſociated ſtrokes, the Coition falls in every fourth. To Contract; the ſame holds in proportion exactly true alſo in Seſquiquartal and Seſquiquintal proportions, from which ariſe Thirds major and minor; and of ſuperbiparting Thirds, and ſupertriparting Fifths, from which ariſe Sixths major and minor; and finally, in all Compound Conſonances, ſuch as Diſdiapaſon, &c. For, alwayes the Conſonance is by ſo much more grateful, by how much more frequently the ſtrokes unite in the Senſory: and *è contra.* Whence is generated the Diſſonancy, or ingratefulneſs of Sounds, when ever the ſtrokes either too rarely, or never unite: becauſe, in thoſe caſes, the ſenſe is held in a kind of laſting diſtraction, and unleſs a reſtitution of the diſtracted parts of the Senſory be made by ſome Coalitions, and thoſe ſufficiently frequent (which are a kind of Balſam, to cure the gratings and diſſolutions) the ſenſory muſt be miſ-affected with a kind of Laceration, and undergo that dolour unwittingly. This the skilful Muſician foreknowing, endeavours to prævent, by making a Diapaſon, or perfect Conſonance tread upon the heels of a Diſſonance, for varieties ſake uſually inſerted into Tunes: thereby with advantage conſolidating the ulceration of the ſenſory cauſed by the præcedent Diſcord, and making the Harmony the more grateful; as Health is moſt grateful immediately after ſickneſs, and a Calme after a Tempeſt. And this is the reaſon, why an Eighth is by many reputed a more pleaſing Conſonance, than an Alniſon; *viz.* in reſpect of the Diſtraction, which ſucceeds alternately from the Diſſociated ſtrokes of one of two ſtrings together percuſt: and not in reſpect of its Comprehenſion of all other Conſonances, as *Des Cartes* ſeems to conclude (*in cap. 8. Compend Muſic.*)

Art. 5. The ſame Analytically præſented in *Scheme.*

If this Genealogy of all Muſical Conſonances ſeem either obſcure, or tædious; you may pleaſe to accept it in Epitome, thus. The Vibrations of Chords are, according to moſt exact obſervation reciprocally proportional

to the { Length of / Weight at } the ſtring, having the ſame { Weight. / Length. }

Whence many have concluded, that all Conſonances in Muſick proceed from the ſpeedier Union of theſe Vibrations in their Terms.

The Terms of an	are in proportion, as	therefore the ſpace of	Vibrations, in the Graver Term, are juſt equal to	Vibrations in the Acuter Term of an
Eighth ——	2 to 1	1	2	Eighth.
Fifth ——	3 — 2	2	3	Fifth.
Fourth ——	4 — 3	3	4	Fourth.
Sixth major--	5 — 3	3	5	Sixth major.
Third major-	5 — 4	4	5	Third major.
Third minor-	6 — 5	5	6	Third minor.
Sixth minor-	8 — 5	5	8	Sixth minor.

Hereupon our Harmonical Authors (whoſe Pythagorean ſouls feaſt themſelves with the raviſhing, though ſilent Muſick of Numbers) for the moſt part account an Eighth the Firſt of Conſonances, becauſe an Union is made before a ſecond Vibration in the Graver Term; a Fifth the ſecond Conſonance, becauſe an Union is made before a third Vibration in the Graver Term, &c. according to the Scheme.

Art. 6. A juſt and unanſwerable *Exception* againſt the former Harmonical Hypotheſis

But this ſo univerſally celebrated Melothetical Foundation hath been very lately ſhook by that no leſs Erudite, than Noble Author of the *Animadverſions on Des Cartes Muſick Compendium, the Lord Viſcount Brouncker*; (whoſe conſtant Friendſhip, and learned Converſation, I muſt profeſs to have been one of the cheifeſt Conſolations of my life.) who having, upon profound, and equitable examination, found this great defect therein, that according to the former Derivation of all Muſical Conſonances, a Third Major muſt ſucceed a Fourth and Sixth Major, and the proportion of 7 to 5 makes a Conſonance as well, and before a Sixth minor; which is manifeſtly repugnant to Experience: hath enriched the world with a new *Hypotheſis* of his own happy invention, ſufficiently extenſible to the full ſolution of all Muſical Phænomenaes. According to which the Conſonances ariſe (phyſically) from the Vibrations of Chords, not in reſpect of their Union, but *Ratio-Harmonical Proportion*, as He is pleaſed to call it: and this upon very good reaſon, ſince, the Vibrations being proportional to the Chords, and the Chords ſo proportionally divided; it is of meer neceſſity, that their Vibrations have the ſame proportions. But of this, the Competent Enquirer may underſtand more from his *Animadverſions*, &c.

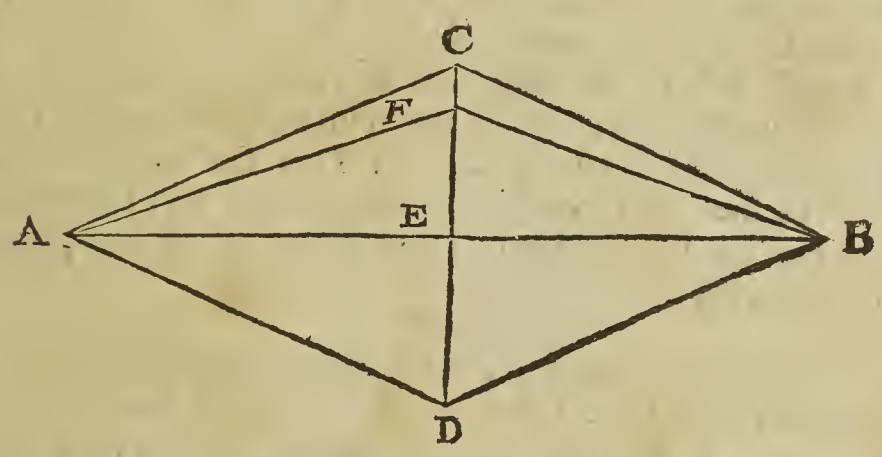
And

And this ſpeculation, touching the Nativity of Muſical Conſonances, hath engaged us to touch upon that Quickſand, from which none the moſt adventurous Curioſity hath ever yet returned with full reſolution; and that is that eminent PROBLEM, *Quando ſonus Harmonicus à nervo fieri incipiat? In what inſtant an Harmonical Sound, created by a Chord of an inſtrument percuſſed, or abduced from its directneſs, is begun?*

Art. 7. PROBLEM I. In what inſtant, an Harmonical Sound, reſulting from a Chord percuſſed, is begun.

For the clear underſtanding of this *Quæſtion*, we are firſt to advertiſe; that from the percuſſion of any Chord diſtended, there are made two different Sounds: *one* ariſing from the alliſion of the Aer betwixt the finger, or plectrum, and the Chord; which is ſo far from being Concinnous, that it frequently diminiſheth the integrity or ſweetneſs of the Muſick, and alwayes makes a kind of Diſcord, where the unskilfull hand ſtrikes too hard or foul; the other, from the Chord verberating the Aer in its Vibrations; which is the Concinnous, or Harmonical Sound, by the Græcians, for diſtinction ſake, called φθόγγος, and in our language the *Twang*. And this is the ſubject of the præſent Enquiry. Secondly, we are to præmiſe this

DIAGRAM.



Wherein A B denotes the Chord, in a ſtreight line, either perpendicularly, or horizontally diſtended; A B C the ſame Chord abduced, or impelled from the direct line to C; and F the ſame in the extreme or term of its ſpontaneous Flexion, after ſome certain recurſes. And laſtly, we are to ſtate the Quæſtion, thus. Whether the Concinnous Sound beginns from the Firſt Excurſe, which is made by the Chord from E to C, when it is impelled by the force of the percuſſion; or, when it returns, by ſpontaneous reflection, from C to E; or, when it hath paſt beyond E to D; or, in its whole Recurſe from D, by E, to C?

(1) Some there are, who obſerving that, when a Chord is abduced from its direct line E to C, and returns it ſelf from C to E, if a piece of wollen cloth, a mans finger, or ought elſe that may ſuppreſs its motion, be ſo ſet as to arreſt it at E; then is no Harmonical ſound created, either in its firſt Excurſe from E to C, nor Recurſe from C to E: have upon this Experience concluded, that the Concinnous Sound is begun in the firſt Recurſe of the Chord from D to E; becauſe they ſuppoſe, the Chord then to reverberate the Aer, which purſued it (*à tergo*) from C to D, and force it by contrary

violence to fly back again from D to C by E: so that the Aer at E, being on both sides distrest by that moving violently from C to E, on one hand, and that lastly impelled from D to E, on the other, must suffer the highest Condensation, or Compression, or Percussion of all the other aer within the space C D, and consequently be the original of the Sound.

(2) *Others* have affirmed the original of the Sound to be from C to E, the space of the first Recurse: and their inducement thereto is this Experience. If a Chord of 30 perches length be with sufficient force extended, and then abduced from its line of direction to the distance of 15 feet, more or less; it will yeild a kind of stridor, or grave sibilation, in its spontaneous Recurse from C to E: which sound would perhaps be Concinnous, if included in some Instrument of sufficient capacity. To which they add, that wands or rodds being switcht in the aer, and Gun-shot in their flight, emitt a singing noyse, though they are impelled only one way, and have no Recurses, or doublings in the aer. But, to this it may be *Answered*, (1) That all these Bodies may more justly be conceived to yeild a sound only in this respect; that the inæqualities in their superficies so distress the aer in their rapid Motion, and by frequent reciprocations in their small cavities variously agitate the same, that it suffers such Circumvolutions as are tantamont to their Recurses. (2) That no Bullet shot from a Gun would yeild any sound at all, if it were exactly sphærical, polite, and hard, and flew directly without that Volutation, or Circumvolution, which the resistence and circular returns of the aer constantly impress upon it. (3) That the Sibilation or Hissing noise made by the long Chord, in its Recurse from the 15 feet abduction, is not, nor ever can be Concinnous: and therefore the Experience is impertinent to this Problem.

(3) A Third sort there is, who opinion the Harmonical Sound then to begin, when the Chord is first impelled from E to C; so that the Chord should produce a Sound in the extremity or period of every Flexion, i. e. in C and D, at alternate Recurses: and consequently, that no sensible Sound is produced in any part of the whole intermediate space betwixt C D. And the Ground These stand upon, is the Experience of Cloth, which being violently shook in the aer, for the excussion of dust, doth only then emit a smart sound, or Rapp, when attaining the extremity of its Flexion, it percusseth the superior aer, and is in the manner of Sails, swelled up by the inferior aer. But, in this instance, and that consimilar one of Coach-whips, it is almost evident even to the eye, that the Rapp is made only by the Doubling of the Cloth, or Chord, at the end of their Flexion: and therefore we are not convinced, that the Concinnous Sound is then begun, as these persuade, in either C or D the period of each Flexion; especially, when the Chord in C and D seems rather to quiesce, than move; and some quiet must intercede betwixt two contrary motions of the same thing.

(4) But, insomuch as all sounds are caused by the Motion of the Aer; and the Sound alwayes is loudest, where the Motion of the Aer is most rapid; and in the whole sonorous line, or space betwixt C and E, the motion

motion of the Aer intercluded is moſt ſwift, when the Chord returns from C to E: therefore doth *Merſennus* (to whoſe judgment we moſt incline, in this nicety) conclude; that the Harmonical ſound is begun in the beginning of the firſt Recurſe of the Chord from C to E: and that it is then of the ſame Acuteneſs, as are all the ſubſequent ſounds made by the ſubſequent Recurſes; becauſe the reaſon of the Firſt Recurſe ſeems to be the ſame with that of all the conſequent.

To this ſome have *objected*; that the ſound of the Firſt Recurſe is too Expedite and ſhort, to be perceived by the Ear: ſince even the Eye, incomparably more prompt in the diſcernment of viſibles, cannot behold an object, whoſe Apparence, or Præſence exceeds not the Duration of the foreſaid Recurſe of the Chord from the extreme of its flexion C to E; which doth ſcarce endure the $\frac{1}{600}$ part of a minute. But this objection is ſoon *diſſolved* by Experience, which teſtifieth, that if a quill, or other impediment be placed ſome ſmall ſpace beyond E towards D, ſo that the Chord may complete its firſt Recurſe from C to E, without interruption: then will a ſound be created, and ſuch as hath ſufficient Acuteneſs; though it be ſcarce momentany in Duration, becauſe the frequency of its Recurſes is prævented.

Many other *Problems* there are, concerning the Reaſons of Sounds, wherewith the inſatiate Curioſity of Naturaliſts hath entertained it ſelf, in all ages: but, among them all we ſhall take cognizance of only thoſe more eminent ones, which as they ſeem moſt irreconcilably repugnant to our Theory, when propoſed; ſo muſt they much confirm and illuſtrate the dignity thereof, when clearly Diſſolved by us, without the leaſt contradiction to, or apoſtacy from our Principles aſſumed. Since the unſtrained Solution of the moſt difficult Phænomenaes, by the vertue of any Hypotheſis, is the beſt argument of its Verity and excellency above others, that fail in their Deduction to remote Particulars.

PROBLEM 2.

Whether may a Sound be created in a Vacuum, if any ſuch be in Nature?

Art. 8. That a Sound may be created in a Vacuum; contrary to *Athanaſ. Kircher in Art. Magn. Conſoni & Diſſoni lib.* 1. *cap.* 6. *Digreſſione.*

SOLUT.

To ſolve this (by many accounted inexplicable) Ænigme, we need only to have recurſe to our long ſince antecedent Diſtinction of a Vacuity *Diſſeminate*, and *Coacervate*: for, that once entered our judgment, we cannot indubitate that ingenious Experiment of *Gaſpar Berthius*, laureat Mathematician at *Rome* (frequently, and alwayes with honourable Attributes, mentioned by Father *Kircher*, in ſundry of his Phyſicomathematical diſcourſes) which ſenſibly demonſtrateth the actual production of a Sound, in a Diſſeminate Vacuity.

The *Experiment* is thus made. Having præpared a large Concave and almoſt ſphærical Glaſs, æmulating the figure of a Cucurbite or Cupping-glaſs; fix a ſmall Bell, ſuch as is uſual in ſtriking Watches of the

the largeſt ſize, on one ſide of the concave thereof, and a moveable Hammer, or ſtriker, at fit diſtance, on the other, ſo as the Hammer being elevated may fall upon the skirts of the Bell: and then lute or cœment on the Glaſs, firmly and cloſely (that all ſenſible inſinuation of the ambient aer be prævented) to one extreme of a Glaſs Tube, of about an inch diametre in bore, and 8 or 10 feet in length. Then, reverſing the Tube, pour into it a ſufficient quantity of Quickſilver, or Water, to fill both it and the Head exactly. This done, ſtop the other extreme of the Tube with your finger, or other ſtopple accommodate to the orifice; and after gentle inverſion, immerge the ſame to a foot depth in a Veſſel of Water, and withdraw your ſtopple, that ſo much of the Quickſilver contained in the Head and Tube, as is ſuperior in Gravity to the Cylindre of Aer, from the ſummity of the Atmoſphere incumbent on the ſurface of the Water in the ſubjacent Veſſel may fall down, leaving a conſiderable void Space in the ſuperior part of the Tube. Laſtly, apply a vigorous Loadſtone to the outſide of the Glaſs Head, in the part reſpecting the moveable extreme of the Hammer; that ſo, by its Magnetical Effluxions tranſmitted through the incontiguities or minute pores of the Glaſs, and faſtned on to its *Anſulæ* or ſmal Holds, it may elevate the ſame: which upon the ſubduction of its Attrahent, or Elevator, will inſtantly relapſe upon the Bell, and by that percuſſion produce a clear and ſhrill ſound, not much weaker than that emitted from the ſame Bell and Hammer, in open aer.

Now, that there is a certain Vacuity in that ſpace of the Head and Tube deſerted by the delapſed Quickſilver, is ſufficiently conſpicuous even from hence; that the ambient Aer ſeems ſo excluded on all hands, that it cannot by its *Perioſis* (to borrow *Platoes* word) or *Circumpulſion*, ſucceed into the room abandoned by the Quickſilver, and ſo redintegrate the ſolution of Continuity, as in all other motions.

And that this Vacuity is not Total, or Coacervate, but only Gradual or *Deſſeminate*, may be warrantably inferred from hence; (1) That Nature is uncapable of ſo great a wound, as a Coacervate Vacuity of ſuch large dimenſions, as we have argued in our Chapter of a *Vacuum Præternatural*, in the Firſt Book: (2) That a Sound is produced therein, for ſince a Sound is an Affection of the Aer, or rather, the Aer is the Material Cauſe of a Sound, were there no aer in the Deſert ſpace, there could be no Sound. Wherefore, it is moſt probable, that in this ſo great diſtreſs ingenious Nature doth relieve herſelf by the inſenſible tranſmiſſion of the moſt æthereal or ſubtile particles of the Circumpulſed Aer, through the ſmall and even with a microſcope inviſible Pores of the Glaſs, into the Deſert Space; which repleniſh it to ſuch a degree, as to prævent a Total though not a Diſperſed Vacuity therein: and though the Groſſer Parts of the extremly compreſt Aer cannot likewiſe permeate the ſame ſlender or narrow Inlets; yet is that no impediment to the Creation of a Sound therein, becauſe the moſt tenuious and æthereal part of the aer, is not only a ſufficient, but the ſole material of a Sound, as we have more than intimated in the 15. *Art.* 2. *Sect. of the preſent Chapter.*

The

The only Difficulty remaining, therefore, is only this; *Why the ſound made in the diſſeminate Vacuity ſhould through the Glaſs-head paſs ſo eaſily and imperturbed, as to be heard by any in the circumſtant ſpace; when common Experience certifieth, that the Report of a Cannon, at the diſtance of only a few yards, cannot be heard through a Glaſs window into a room void of all chinks or crannies?*

Nor need any man deſpair of expeding it. For, whoſo conſiders the extraordinary and inſcrutable wayes to which Nature frequently recurrs, in caſes of extreme Neceſſity; and that the Diſtreſs ſhe undergoes in the introduction of this violent Vacuity (where her uſual remedy the Periſtaltick motion, or Circumpulſion of the Aer, is prævented by the interpoſition of a Solid) is much more urgent than that ſhe is put to in the Compreſſion of the ambient aer by the exploſion of Canons (where the amplitude of uninterrupted ſpace affords freedome of range to the motion impreſt) we ſay, whoſo well conſiders theſe things, cannot doubt, but that it is much eaſier to Nature to admit the trajection of the Sound produced in the Diſſeminate Vacuity, through the pores of the Glaſs-head, than the tranſmiſſion of an External Sound into a cloſe Chamber, through a Glaſs window, where is no Concavity for the Corroboration or Multiplication of the Sound, and conſequently where the impulſe is far leſs (reſpective to the quantity of the aer percuſſed) and the reſiſtence as much greater.

PROBLEM, 3.

Art. 9. Why all Sounds appear more Acute, at large, than at ſmall diſtance?

Whence is it, that all Sounds ſeem ſomewhat more Acute, when heard far off; and more Grave, near at hand: when the Contrary Effect is expected from their Cauſes, it being demonſtrated, that the Gravity of a Sound ariſeth (mediately, at leaſt) from the Tardity, and Acuteneſs from the Velocity of the Motion, that createth it; and many great Clerks have affirmed, that the motion of a Sound is leſs ſwift far off from, than near to its origine, according to that General Law of Motion, omnia corpora ab externo mota, tanto tardius moventur, quanto à ſuo principio remotiora fuerint?

SOLUT.

No Sound is Really, but only *Apparently* more acute at great, then at ſmall diſtance; and the Cauſe of that ſemblance is meerly this: that every Sound, near its origine, in regard of the more vehement Commotion, and proportionate reſiſtence of the Aer, dependent on its natural Elater, or Expanſory Faculty, doth ſuffer ſome Obtuſion, or Flatning; which gradually diminiſhing in its progreſs or Delation through the remoter parts of the Medium, the Sound becomes more Clean, Even and Exile, and that *Exility* counterfeits a kind of *Acuteneſs*.

PROBLEM 4.

Art. 10. Why Cold water falling, makes a fuller noiſe, than warm.

Why doth Cold Water, in its effuſion from a Veſſel, make a more full and acute noiſe, than Hot or Warm?

SOLUT.

SOLUT.

The ſubſtance of Cold Water, being more Denſe and Compact, muſt be more weighty, and conſequently more ſwift in its fall, and ſo the noiſe reſulting from its impulſion of the aer, more ſharp than that of Hot: which being rarefied by the fire, or made more lax in the contexture of its particles, looſeth ſomething of its former weight, and ſo hath a ſlower deſcent, and in reſpect of that ſlowneſs, produceth a weaker and flatter ſound. And this is alſo the reaſon, why *Iron* hot yieldeth not ſo ſmart and full a ſound, as when 'tis cold.

PROBLEM 5.

Art. 11. Why the voice of a Calf is more Baſe than that of an Ox, &c.

Why is the Lowing of a Calf much more Deep, or Baſe, than that of an Oxe, Cow, or Bull, at their ſtandard of growth: contrary to all other Animals, which have their voices more ſhrill and acute, when they are young, than when they are old?

SOLUT.

The Cauſe of this ſingularity is found only in the peculiar Conſtitution of the *Larynx* of a Calf; which is in amplitude equal to, and in laxity and moyſture much exceeds that of an Oxe, Cow, or Bull full grown; and ſo Age doth Contract and Harden, not ampliate the ſame, as in all other Animals: and it is well known that the wideneſs and laxity of the *Aſper Artery*, is the cauſe of all Grave or Baſe Voyces.

PROBLEM 6.

Art. 12. Why a Diſſonance in a Baſe is more deprehenſible by the ear, than in a Treble voice.

Why is a Diſſonance more eaſily diſcovered by the ear, in a Barytonous, or Baſe Voyce, or Tone, than in an Oxytonous or Treble?

SOLUT.

Becauſe the Barytonous voyce is of a ſlow Motion, and the Oxytonous of a ſwift: and the ſence doth ever deprehend that object whoſe apparence is more durable, more clearly and diſtinctly than that, whoſe apparence is only inſtantaneous, or leſs laſting.

CHAP.

CHAP. VII.

OF

ODOVRS.

SECT. I.

Art. I. That the Cognition of the Nature of Odours is very difficult; in respect of the *Imperfection* of the sense of *Smelling*, in man: and

WHoever is natively deprived of any one sense, saith *Aristotle* (*in Analyticis*) is much less capable of any Science, than He who hath all five Fingers on the left hand of his soul (to use the metaphor of *Casserius Placentinus*, *in præfat. ad lib. de sens. Organ.*) or all the Organs of the sensitive Faculty complete: and His reason is that General Canon; *Nihil est in intellectu, quod non prius fuerit in sensu*; the senses being the Windows, through which the soul takes in her ideas of the nature of sensible Objects. If so, whoever hath any one sense less perfect than the others, can hardly attain the Knowledge of the nature of objects proper to that sense: and upon consequence, the Cognition of the Essence of an ODOURE must be so much more difficult to acquire, than that of Visibles and Audibles, by how much less perfect the sense of SMELLING is in man, than the sight and Hearing. And, that Man, generally, is not endowed (for, we may not, with our noble Country man Sir *Kenelme Digby* charge this imperfection altogether upon the Errors of our Diet; because we yet want a Parallel for his *John of Liege*, who being bred savagely among wild beasts, in the Forrest of *Ardenna*, could wind his pursuers at as great distance, as Vultures do their prey, and after his Cicuration or reduction to conversation with men, retained so much of the former sagacity of his nose, that He could hunt out his absenr friends by the smell of their footsteps, like our Blood-Hounds) we say, that man is not generally endowed with exquisiteness of smell; needs no other eviction, but this: that He doth not deprehend or distinguish any but the stronger, or vehement sorts of Odours; and those either very offensive, or very Grateful.

Art. 2. The contrary opinions of *Phylosophers*, concerning it.

But, albeit this difficulty of acquiring the knowledge of the Essence and immediate Causes of Odours, hath its origine in the native Imperfection of our sense accommodate to the perception thereof: yet hath it received no small advance from the obscurity of our *Intectuals*, the Errors of human judgement, and the common Effect thereof, the contrary Opinions of Philosophers. For, however they unanimously decree, that the proper object of smelling is an *Odour*; and the adæquate *sensory*, ordained for the apprehension of it, the *Mammillary Processes* of the brain, or two nervous productions derived to the basis of the nose: yet could they never agree about the chief subject of their dispute, the *Quiddity*, or *Form* of an Odour; or the *Commensuration* betwixt the same, and the odoratory Nerves, the theory whereof seems most necessary to the explanation of the Reason and Manner of its Perception and Distinction by them.

Art. 3. Some determining an Odour to be a *substance*

Thus, on one side of the schools, *Heraclitus*, cited by *Aristotle* (*de sensu & sensili, cap.*5.) is positive, that the smell is not affected with only an Incorporeal Quality, or spiritual species; but that a certain subtle *substance* [καπνῶδης ἀναθυμίασις] or Corporeal Exhalation, emitted from the odorous object, doth really and materially invade and affect the sensory.

(2) And *Epicurus* (*in Epist. ad Herodot. apud Diogen. Laertium, lib.* 10.) seconds him with somewhat a louder voice; *Existimandum est, Odorem non facturum ullam sui impressionem, nisi ab odora re usq; deferrentur moleculæ seu Corpuscula quædam, ea ratione Commensurata ipsi olfactus sensorio, ut ipsum moveant afficiant ve; alia quidem perturbate ac discrepanter, ex quo odores Ingrati sunt; alia placide & accommodate, ex quo Jucundi sunt odores:* "men are to conceive, that an Odour could make no sensi-"ble impression of it self, unless there were transferred from the odorous "object certain substantial Effluxes, or minute Bodies, so Commensurate or "Analogous to the peculiar Contexture of the Organ of smelling, as to "be capable of affecting the same; and those either perturbdly and discor-"dantly, whence some Odours are Ingrateful, or amicably and conveni-"ently, and those Odours are Grateful.

(3) And *Galen*, attended on by most of the Æsculapian Tribe, sings the same tune, and in as high a key as either of the Former; saying, (*in lib. de instrum. olfact. cap.* 2.) *Id quod à rerum corporibus exhalat, Odoris substantia est:* though *Casserius Placentinus* (*de fabric. Nasi, Sect.* 2. *cap.* 3.) hath endeavoured to corrupt the genuine sense of those words, by converting *substantia* into *subjectum*, as if *Galen* intended only that the Exhalation from an odorous body was only the *subjectum inhæsionis*, and the ôdour it self meerly the *Quality* inhærent therein. Contrary to the rules of Fidelity and Ingenuity; because incongruous both the Letter of the Text, and the Syntaxis thereof with his whole Enquiry.

(4) And the Lord *St. Alban*, though a modern, yet not unworthy to enter the Chorus with the noblest among the Ancients, though He had too frequently used his tongue to the Dialect of Immaterial Qualities,

Qualities, and ſpiritual Images, in his diſcourſes of the other ſenſes; doth yet make a perfect uniſon with *Galen*, in this particular, delivering his judgement in moſt full and definite termes, thus: *Certain it is, that no ſmell iſſueth from a body, but with emiſsion of ſome Corporeal ſubſtance*; (*Sylva ſylvar. Cent. 9. experim.* 834.)

On the other ſide, we hear the great Genius of Nature, as his Idolaters miſcall him, *Ariſtotle*, and that moſt numerous of Sects; the *Peripatetick*, vehemently contending, that an Odour belongs to the claſſis of ſimple, or *Immaterial Qualities*; and that though it be wafted or tranſported on the wings of an Exhalation, from the Odorate body to the Senſory: yet is the ſenſory affected onely with the meer *Image*, or *Intentional ſpecies* thereof. *Art.* 4. Others, a meer *Accident* or *Quality*.

Now the moments of *Authority* being thus equal on both ſides; our province is to determine the ſcales by the præpondium of *Reaſon*, i.e, with an even hand to examine the weight of the Arguments on which each of theſe contrary Opinions is grounded *Art.* 5. The *Baſis* of the *Latter* opinion, infirme and ruinous.

To begin with the *Later*, as the moſt Epidemical and generally entertained; we find the principal Baſe of it to be only that common Axiome, *Senſus non percipiunt ſubſtantias, ſed tantum earum Accidentia*, that no ſenſe is invaded and actuated into ſenſation by the Real or Material; but onely the intentional ſpecies of the Object: which being weak of it ſelf, and by us frequently ſubverted in our præcedent Diſcourſes; the whole ſuperſtructure thereon relying is already ruined, and they who will reædifie it, muſt lay a new foundation.

But, as to the *Former*, that an *Odour is a perfect ſubſtance*, by material impreſſion on the Senſory cauſing a ſenſation of it ſelf therein; this ſeems a Truth ſtanding upon ſuch firm feet of its own; that it contemns the crutches of ſophiſtry. For

(1) No Academick can be ſo obſtinate, as not to acknowledge, that there is a certain Effluvium, or Corporeal Exhalation from all odorous bodies, diffuſed and tranſmitted through the aer; as well becauſe his own obſervation doth aſcertain him, that all Aromatiques and other odorous bodies, in tract of a few years, confeſs a ſubſtantial Contabeſcence, or decay of Quantity; which makes our Druggiſts and Apothecaries conſerve their parcels of Ambre Griſe, Musk, Civit, and other rich Perfumes, in bladders, and thoſe immured in Glaſſes, to prævent the exhauſtion of them by ſpontaneous emanation: as for this, that the odour doth moſt commonly continue vigorous in the medium, a good while after the remove of the ſource, or body from which it was effuſed. And *Ariſtotle* himſelf, after his peremptory Negative, *Odorem non eſſe* Ἀπορροίαν, *Effluxionem*: could not but let ſlip this Affirmative, ὅσον ἀπορρεῖ τῶν σωμάτων τοῦτ' ἐστὶ τῆς ὀσφρά-νου, *quod effluit ex corporibus, ipſa eſt odorum ſubſtantia*. *Art.* 6. That all odorous Bodies emit *corporeal* Exhalations.

(2) Common Experience confirms, that odours are vigorous and potent, not only in the production of ſundry Affections in the brain, good or evil, according to their vehemency and Grateful neſs or Noyſomneſs, by the refocillation or pollution of the ſpirits; but alſo in the *Art.* 7. That Odours cauſe ſundry *Affections* in our Bodies, and ſuch as are conſignable only to *ſubſtances*.

Vellication and frequently the Corrosion of tender investment of the Nostrills. Thus much the reverend Oracle of *Cous* well observed in 28 *Aphorisme* 5 *Sect.*; *Odoramentorum suffitus muliebria educit, & ad alia plærumque utilis esset, nisi gravitatem capitis inferret*: and *Galen* supports with his opinion and arguments, that pleasant Odours are a kinde of Nourishment of the spirits. Besides, *Plutarch* reports, that He observed Catts grow mad onely by the smell of certain odoriferous Unguents: and *Levinus Lemnius* (*de Natur. miracul*) hath a memorable story of certain Travellers, who passing through large fields of Beans in the Flower, in Holland, become Phrantick meerly with the strength of their smell. And all Physicians dayly finde, that good smels, by a recreation of the languid spirits, speedily restore men from swooning fits; as evil scents often induce Vomitings, syncopes, Vertigoes, and other suddain symptomes. Nay, scarce an Author, who hath written of the Plague and its Causes, but abounds in relations of those accursed miscreants, who have kindled most mortal infections, by certain Veneficious practices, and Compositions of putrid and noysom Odours: witness *Petrus Droetus* (*de pestilentia, cap.*10.) *Wierus* (*de Venificiis lib.*3.*cap.*37.) *Horatius Augenius* (*lib. de peste, cap.*3) *Hercules Saxonia* (*de plica, cap.*2.*&* 11.) *Thomas Jordanus* (*de pestis phænomen. tr.*1.*cap* 18.) and *Sennertus*, out of *Nich. Polius in Hæmerologia Silesiæ*, (*in lib. de peste, cap.*2.) Which prodigious Effects clearly proclaim the mighty energy of their Causes, and are manifestoes sufficient, that Odours justly challenge to themselves those Attributes; which are proper onely to *Corporiety*: nor can ought but downright ignorance expect them from the naked *Immaterial Qualities*, or imaginary *Images* of the *Peripatetick*.

(8 *de Compos. medic. secund. loca, cap.*4.)

Art. 8. That the *Reason* of an Odours affecting the sensory, consists only in a certain *Symbolisme* betwixt the Figures and Contexture of its Particles, and the Figures and Contexture of the Particles of the Odoratory Nerves.

(3) The Manner of the Odours moving, or Affecting the Sensory can never be explained, but by assuming a certain *Commensuration*, or Correspondency betwixt the Particles amassing the Odour, and the Contexture of the Olfactory Nerves, or Mammillary Processes of the brain delated through the spongy bone. For (1) it is Canonical, that no Immaterial can Operate upon a Material, *Physically*; the inexplicable activity of the Rational Soul upon the body by the mediation of the spirits, and that of Angelical essences excepted. (2) Though an Odour, diffused through the aer, chance to touch upon the hands, cheeks, lips, tongue, &c. yet doth it therein produce no sensation of it self; because the Particles of it hold no proportion to either the pores, or particles of which those parts are composed: but arriving at the organ of smelling, it cannot but instantly excite the Faculty therein resident to an actual sensation, or apprehension of it; in regard of that correspondency in Figure and Contexture, which the particles of it hold to the pores and particles of the Odoratory Nerves. Certainly, as the Contexture of the Odoratory Nerves is altogether different from that of the Tongue; and so the minute bodies of them, as well as the small spaces intercepted among those minute bodies, in all points of their superficies not contingent, are likewise of a dissimilar configuration from the particles and intercepted *vacuola* of the Tongue: so also is it necessary, that the small bodies, which commove and affect the Contexture of the Odoratory Nerves, be altogether dissimilar to those, which commove and affect the contexture of the Tongue; since, otherwise all objects would be in common, and the Distinction of senses unnecessary.

Now

Now (left we ſhould ſeem to beg the Quæſtion) that the ſenſation is effected in the Odoratory Nerves, only by the *Figures* of the particles of an Odour; and that the variety of Odours depends on the variety of impreſſions made on the ſenſory, reſpective to their various figures and contextures: this is not obſcurely intimated in thoſe formerly recited words of *Epicurus*, *Molecularum, ſive Corpuſculorum quædam perturbate ac diſcrepanter, quædam verò placide ac leniter, ſeu accommodatè ſe habere, ad olfactus ſenſorium.* The ſubſtance whereof is this, that becauſe the particles and Contexture of ſome Odours are ſuch, that they ſtrike the ſenſory roughly and diſcordantly to the contexture thereof; therefore are they *Ingrateful:* and on the contrary, becauſe other Odours have ſuch particles and ſuch contextures, as being ſmooth in Figure, ſtrike the ſenſory gently, evenly and concordantly to the contexture thereof; therefore are they *Grateful* and deſiderable. We might have introduced *Plato* himſelf, as lighting the tapor to us, in this particular; inſomuch as He ſaith (*in Timæo*) that the ſweet ſort of Odours [καταπραῦνον καὶ ἃ πέφυκεν, ἀγαπητῶς ἀποδιδόν] *de mulcere, & quâ inſeritur, amicabiliter ſe habere*, doth ſoftly ſtroke, and cauſe a certain blandiſhment in the ſenſory: but, that the kinde of noyſom or ſtinking Odours [τραχῦνον τε καὶ βιαζόμενον] doth in a manner Exaſperate and wound it. To this Incongruity or Diſproportion betwixt offenſive ſmells and the compoſure of the Odoratory Nerves, the profound *Fracaſtorius* plainly alludeth, in his; *proportionaliter autem ſe habent & odores, quorum ingratiſsimus eſt, qui Fætidus appellatur, quique abominabili in ſaporibus reſpondet; nam & hic ex iis pariter reſultat, quæ nullam habent digeſtionem, nec rationem miſtionis, ſed confuſionem è multis fere ac diverſis, qualia fere ſunt Putreſcentia, in quibus diſſoluta miſtione evaporatio diverſorum contingit.* (*de ſympath. & antipath. cap.* 14.) importing withal, that the reaſon why the ſtink of corrupting Carcaſſes is of all other moſt noyſom, is becauſe the odours effuming from them conſiſt of heterogeneous or divers particles. If you had rather hear this in Verſe, be pleaſed to liſten to that Tetraſtich of *Lucretius*;

Art. 9. That the *Diverſity* of Odours depends on the Diverſity of Impreſſions made on the ſenſory, reſpondent to the various Figures and Contexture of their Particles.

Non ſimile penetrare, putes, primordia formâ
In nares hominum, cum tætra Cadavera torrent;
Et cum Scena Croco Cilici perfuſa recens eſt,
Araq; Panchæos exhalat propter odores.

Upon which we may juſtly thus deſcant. As the hand touching a lock of wool, is pleaſed with the ſoftneſs of it; but graſping a Nettle, is injured by that phalanx of villous ſtings, wherewith Nature hath guarded the leaves thereof: ſo are the Noſtrills invaded with the odour of Saffron, delighted therewith, becauſe the particles of it are ſmooth in figure, and of equal contexture; but invaded with the odour of a putrid Carcaſe, they are highly offended, becauſe the particles thereof are aſper in figure and of unequal contexture, and ſo prick and dilacerate the tender ſenſory.

Moreover, whereas there is ſo great variety of individual Temperaments among men, and ſome have the Contexture of their odoratory Nerves exceeding diſſimilar to that of others; hence may we well derive the Cauſe of that ſo much admired ſecret; *Why thoſe Odours, which are not*

Art. 10. Why ſome Perſons abhor thoſe ſmells, which are grateful to moſt others.

not onely grateful, but even highly cordial to ſome perſons, are moſt odious and almoſt poyſonous to others. Infinite are the Examples recorded by Phyſicians, in this kinde; but none more memorable than that remembred by *Plutarch* (*lib.* 1. *adverſ. Coloten.*) of *Berenice* and a certain Spartan woman, who meeting each other inſtantly diſliked and fainted, becauſe the one ſmelt of Butter, the other of a certain fragrant Ointment. However, the rarity of the Accident will not permit us to paſs over the mention of a Lady of honor and eminent prudence, now living in *London*; who doth uſually ſwoon at the ſmell of a Roſe (the Queen of ſweets:) and ſometimes feaſts her noſe with Aſſa fætida (the Devils Turd, as ſome call it) than which no favour is generally held more abominable; and this out of no Affectation, for her wiſdom and modeſty exclude that prætence, nor to prevent Fitts of the Mother, for ſhe never knew an Hyſterical paſſion, but in others, in all her life, as ſhe hath frequently proteſted to me, who have ſerved her as Phyſician many years.

Art. 11. Why, among *Beaſts*, ſome *ſpecies* are offended at thoſe ſcents in which others highly delight

Again, as this Aſſumption of the Corporiety of an Odour doth eaſily ſolve the Sympathies and Antipathies obſerved among men, to particular ſmells; ſo likewiſe doth it yield a plain and ſatisfactory reaſon, why ſome Bruit Animals are pleaſed with thoſe Odours; which are extremely hateful to others. Why Doggs abhorr the ſmell of Wine, and are ſo much delighted with the ſtink of Carrion, as they are loath to leave it behind them, and therefore tumble on it to perfume their skins therewith? Why a Cat ſo much diſlikes the ſmell of Rue, that ſhe will avoid a Mouſe that is rubbd with the juice thereof; as *Africanus* (*in Geoponicis*)? Why Mice are poyſoned with the ſcent of Rododaphne, or Oleander, commonly named Roſe-bay-tree; as *Apuleius*, and from him *Weckerus* (*de ſecretis Animal.*)? Why Serpents are driven from Gardens by the ſmell of Citrons as *Galen* affirms; when yet they ſolace themſelves with that of Savin, which our noſe condemns? Why Cocks cannot endure the breath of Garlick; which is ſoveraign incenſe to Turkeys, and pure Alchermes to their drooping yong ones? Why Moths are deſtroyed by the fume of Hopps; which is Ambre Griſe to Bees, as *Mouffet* (*de inſectis*)? For the Cauſe hereof wholly conſiſts in the Similitude or Diſſimilitude betwixt the particular Contexture of the Senſory, and the Figures of the particles of the odour.

Art. 12. The *Generation* and *Diffuſion* of Odours, due only to *Heat*.

The Materiality of an Odour being thus firmly commonſtrated; the next Conſiderable is the *Generation*, and proxime *Efficient Cauſe* thereof. And herein *Ariſtotle* came neerer the truth, than in his conception of the Eſſence of it; for that Aſſertion of his, *Odorem gigni & moveri beneficio Caloris*, that Heat conduceth both to the Generation and Motion or Diffuſion of an Odour, doth well deſerve our aſſent. For, whether thoſe minute Maſſes, or ſmall Concretions, that conſtitute the body of an Odour, be contained chiefly in ſome ſulphurous ſubſtance, as the Diſſolutions and Experiments of Chymiſtry ſeem to conclude; or ambuſcadoed in any other conſiſtence whatever: yet ſtill is it manifeſt, that they are deduced into act and ſequeſtred from thoſe diſſimilar or heterogeneous bodies of Earth and Water that ſurrund and oppreſs them, and ſo becoming more at liberty and united, they more vigorouſly affect the ſenſe, and all this by the energy of *Heat*. Hence comes it, that all Fruits are ſo much more Fragrant, by how much more Concocted and Maturated by the warmth of the Sun.

That

That all Aromaticks grow in Hot Climats. That all ſmells are ſtronger in Summer, than Winter; as *Plutarch* obſerves (*lib. de Cauſ. Natur. cap.* 25.) where he enquires, why in Froſt wild beaſts leave but a cold ſcent behind them, when they are hunted. That all odoriferous Druggs are Hot, and ſuffer a perpetual exhauſtion or expence of their halituous ſubſtance: ſo that who ſo would conſerve their Fragrancy, muſt embalm them in Oyl, or incorporate them with Gumms, or other ſubſtance not eaſily evaporable; according to the common practice of all Perfumers and Confectioners; or immure them in cloſe conſervatories, and that rather in great lumps, than ſmall fragments, and in Cold rather than Hot rooms. Hence it is alſo, that all Botanicks hold it for an unqueſtionable Axiome, *Omnia Odorata eſſe calida*; ſo that ſome have undertaken to diſtinguiſh of the degrees of Heat in Plants and other Simples, meerly by the vehemence or languor of their Odour: and that *Ariſtotle* (*problem. ſect.* 12. *quæſt.* 12.) affirms that all Odorous ſeeds are Calefactive, becauſe Heat is the Efficient of an Odour; to which *Galen* alſo ſubſcribes (4 *de ſimpl. medicament. facul. cap.* 22.)

Art. 13. The *Differences* of Odours.

From the Nature & Efficient of Odours, we are conducted to their *Difference*, or *Diſtinct ſpecies*; which is an Argument involved not in the leaſt Difficulties. For, ſince the imperfection of our ſenſe of ſmelling is ſuch, that it is affectable only with the more vehement ſort of them, which are but few in compariſon to thoſe many, which the ſagacity of moſt Bruit Animals makes familiar to their deprehenſion, and ſo we remain ignorant of the greateſt part of them; and did we know them, yet ſhould we be to ſeek for proper Appellatives to expreſs their particular natures: to deliver an exact Table of all their Diſtinctions, is not only difficult, but impoſſible. Which Naturaliſts well underſtanding, have been forced to the cleanly ſhift of transferring the diſtinct names of *ſapours* over to the ſpecifical Differences of *Odours*; there being ſome manifeſt ſymboliſm betwixt the two ſenſes, and no obſcure Analogy betwixt the Conditions of their objects: as *Ariſtotle* inſinuates in his Affirmation, *Nullum corpus eſſe odoriferum, quod non pariter ſaporiferum exiſtat* (*de ſenſ & ſenſil. cap.* 5.) that all Odoriferous bodies are alſo ſaporiferous; and in his definition of an *olfactile*, or odorable object to be, *Quod ſapidæ ſiccitatis diluendæ ac diffundendæ vim ſortitur*. Well may we, therefore, content our ſelves with the Diſcrimination of thoſe kinds of Odours, that fall under the Cognizance of our ſenſe; and thoſe are *Sweet*, *Sower*, *Auſtere*, *Acerb*, and *Fatt* or *Luſcious*: as for *Putrid* or Fætid Odours, they have reſemblance to *Bitter Sapours*, becauſe as Bitter things are odious and diſtaſtful to the pallate, and no man ſwallows them without ſome horror and reluctancy, ſo likewiſe doth the Noſe never admit rotten and cadaverous ſmells without loathing and offence. There is alſo another Difference of ſmells, whereof *one* kind is either pleaſant or unpleaſant by Accident, or upon Circumſtance; as the ſmell of Meats and Drinks is pleaſant to the Hungry, but offenſive to the Full-gordged, and this ſort is in common as well to Beaſts, as Men: the *other* is pleaſant, or unpleaſant of their own Nature, as the ſmells of Herbs, Flowers, Perfumes, &c. which conduce neither to the Excitement, nor Abatement of Appetite, unleſs they be admixt to meats or drinks; to which *Stratis* alluded, when taxing *Euripides* he ſaid, *Cum lens coquitur, unguenti nil infundito*, and this Difference is proper only to man. Laſtly, Authors have divided Odours into *Natural*, and *Artificial*, or *Simple* and *Compound*; the Latter whereof our Luxury and Delicacy have enhanced to ſuch immoderate rates;

rates, that the Confection of them is become an Arte, and reduced to certain Dispensatories and set Præscripts, and that Lady is not *al-a-mode*, who hath not her Manuscript of Recipes for Perfumes, nay every street hath its *Myropolies* or shops of sweets, of all sorts.

Art. 14. The *Medium* of Odours.

Finally, the *Medium* inservient to Odoration, is either *Aer*, or *Water*: yet neither according to Essence, but *Infection*, or Imprægnation. That the Aer is a convenient Convoy, or Vehicle of an Odour, no man did ever doubt: and that water hath the like Capacity, or perodorable Faculty, though in an inferiour degree; we may, with *Aristotle* (*de histor. Animal.* 4. *cap.* 8.) conclude from the vulgar Experiment of betraying Fishes with perfumed Baites.

CHAP.

CHAP. VIII.

OF

SAPOURS.

SECT. I.

THE Nature of SAPOURS, the proper object of the Taste, *Aristotle* (*de sens. & sensil. cap.* 4.) concludes to be more easily Cognoscible, than that of Odours, Visibles, or the Objects of the other Senses; because as He præsumes, the sense of Tasting in Man, is more Exquisite, than his Smelling, Sight, &c. Whether his *Reason* be not præcarious, we need not determine: but it too nearly concerns us to affirm, that the extreme slenderness of his doctrine, touching the *Essence* and *Principles*, of Sapours as well in General as Particular; erected on that common imaginary base of Immaterial Qualities, hath given us just occasion to suspect the solidity of his *Inference* or *Conclusion*; and left us cause to account that sentence, much more Canonical, *That things most manifest to the Sense, often prove most obscure to the Understanding.* For, notwithstanding we have the demonstration of our sense, that, as He and all other Philosophers unanimously assert, the Object of the Tasting, in General, is τὸ γεῦστον, *Gustabile*: yet doe his endeavours afford so dimme a light to our profounder inquisitions, as to leave us in the dark of insatisfaction, when We come to explore, What is the *Formal Reason* of a Sapour; What are the *Principles*, or *Material* and *Efficient* Cause thereof; and What *Relation* it bears unto, or *Manner* how it affects the Tongue, the prime and adæquate instrument of Tasting. Which that we may with due fulness and perspicuity declare, it behoveth us to invite your attention to a faithful Summary of His Speculations concerning that Subject.

Art. 1. From the superlative Acuteness of the sense of Tasting, *Aristotle* concludes the cognition of the Nature of Sapours to be more easily acquirable, than the nature of any other sensible object: but refutes himself by the many Errors of his his own Theory, concerning the same.

Art. 2. An Abridgment of his doctrine, concerning the *Essence* and *Causes* of a Sapour, in General.

Aristotle, from whose Text all the *Peripateticks* have not receded insomuch as in a title, as to the particular under debate, fixeth the original of a Sapour, in a certain Contemperation of three prime *Elemental Qualities*; viz. (1) *Terrestrious Siccity.* (2) *Aqueous Humidity.* (3) *Heat.* The two former as the *Material* Causes, the last as the *Efficient*, to which, according to his custome, He consigns the masculine and determinative Energy, as in this, so in all natural productions. The necessity or the Concurrence of these three First Qualities to the Generation of a Sapour in any Concretion, He inferrs chiefly from hence; that Water, being in the purity or simplicity of its essence, absolutely insipid, if percolated through *Siccum terrestre*, adust Earth, doth alwayes acquire a Sapidity, or Savourinesse, proportionate to the intense, or remiss adustion of the terrestrious material dissolved by, and incorporated to it self: as is commonly observable in Fountains, which become imprægnate or tincted with the sapours of those veins of Earth, through whose Meanders and streights they have steered in their long subterraneous voyages; and in all Lixivial decoctions, or Lees, which obtain a manifest Saltness only by transcolation through Ashes, the Earthy and adust reliques of compound bodies, dissolved by Fire. To which, He moreover addes, that because the Contemperature may be various, according to greater or lesser proportion of either of the three ingredients; and the Aqueous *Humidum*, united to the Earthy *Siccum*, hath its consistence sometimes participant of Crassitude, sometime of Tenuity: therefore are not all Sapours alike, but different according to the several Gradualities of their respective and specifical Causes. And thus much in the *General.*

Art. 3. And the *Differences* of Sapours, with the particular Causes of each.

To progress to the brief survey of *Particulars*, it seems requisite that we observe; that *Galen*, *Avicenna*, *Averrhoes*, and most *Physitians* after them, have conceived this Theory of *Aristotles* so firm and imprægnable, as they have thereon founded one of their pillars for the invention of Remedies, and advanced rules for the Conjectural investigation of the manifest Faculties of Medicaments, by the Taste: to that end constituting *Eight Differences*, or Generical Distinctions of Sapours, *viz.*

(1) *Acer*, which affects the mouth and chiefly the Tongue, with a certain acrimony and pungent ardor; such as is eminently conspicuous in *Pepper*, *Pellitory*, *Euphorbium*, *Cassea lignea*, *Winterian Bark*, &c. It ariseth from a Composition of tenuious, dry and hot parts, and cannot subsist in a subject of any other constitution.

(2) *Acid*, or *Sharp*, which likewise penetrateth and biteth the tongue, but with some constringency, and without any sense of heat: such as is deprehended in *Vinegre*, juice of *Limons*, *Citrons*, *Woodsorrel*, *Berberies*, and in some *Malacotones* and *Quinces.* It results from a Concretion of subtle and dry parts, either where the innate heat is resolved by some degree of putrefaction, as in Vinegre: or where the innate heat is so small as to be inferior to Cold, and that associated with extreme siccity; as in juice of Limons, &c.

(3) *Fat*;

(3) *Fat*, or *Luscious*, which sollicites the Gusts neither with heat, nor acrimony; but furrs and daubs the mouth with an unctuous lentor, or viscidity. Such is remarkable in *Oyle Olive*, *Oyle of sweet Almonds*, *Wallnuts*, in *Marrow*, *Butter*, and the *Fats* of Beasts, which have no rancidity, either acquired by antiquity, or natural, such as is perceivable in the Fat of *Lions*, *Wolves*, and *Tigers*: and in all *Mucilaginous Plants*, as in *Althæa* and *White Lilly* roots, &c. This hath its production from a thin aereal matter, temperate in heat and cold.

(4) *Salt*, which doth not much calefie, but with a sharp and penetring siccity bite the tongue; as is observed in the degustation of Common *Salt*, *Nitre*, and among Vegetables chiefly in *Rock Sampier*. This Sapour is also sensible in all *Chymical Salts*, extracted from Bodies by the sequestrating activity of Fire, cinefying their dry and terrestrious remains: nor is there any Compound in Nature, from which pyrotechny may not extract the Calx or proper Salt thereof, discernable by the taste. And therefore it is manifest, that all saltness subsisteth in a matter, whose principal ingredients, Heat and Siccity are equal.

(5) *Austere*, which being moderately adstringent, doth with some asperity coarctate the particles of the tongue, and therefore according to the judgment of the pallate, it seems dry and cooling. This is more properly called the *Crude* Sapour, as being peculiar to all Fruits during their immaturity; as is generally noted in the juice of unripe *Grapes*, *green Apricocks*, *Pears*, *Apples*, *Medlars*, *Porcellane*, *&c.* The substance wherein it consisteth, must be equally participant of Earth and Water, but where Cold hath the upper hand of Heat.

(6) *Sweet*, which being not offensive by the unevenness or exuperance of any Quality, affects the sense with suavity or delight. Such every man knows to be in *Sugar*, *Honey*, *Liquorice*, *Jujubes*, *Dates*, *Figgs*, and in most *Fruits* after their maturity: as also in *Manna*, and, in some degree, in *Milk*.

(7) *Bitter*, the Contrary to Sweet, which offending by the asperity and tenuity of its parts, doth in a manner corrade and divell the sensory. This superlatively discovers it self in *Aloes*, *Coloquyntida*, *Rhubarb*, *Wormwood*, the lesser *Centaury*, *Bitter Almonds* and the *Galls* of Animals. The matter of it is crass and terrene, but adust by immoderate Heat; and hence that Galenical Axiome, *Omne amarum est calidum & siccum.*

(8) *Acerb*, or *Sower*, which bordereth upon the Austere or Pontick Sapour, being distinguishable from it, only by a greater ingratefulness to the sense; for it more constringeth and exasperateth all parts of the mouth, and so seems more exsiccative and refrigerative. It is prodigally perceived in the *rind* of *Pomegranates*, *Galls*, *Sumach*, *Cypress Nuts*, the *Bark* of *Oak*, the *Cups of Achorns*, *&c.* Its residence is alwayes in a Composition totally terrene and drye, whose languid heat is subdued to inactivity by the superior force of its antagonist, Cold.

To these some Modern Physitians (to whom that Mystagogus or Priest of the Arabian Oracles, *Fernelius*, seems to have been the Coryphæus) have superadded a ninth Sapour, ἀποίΘ, the *Fatuous*; which affecting the sense with no impression, is indeed no Sapour, but rather the Privation of all Sapidity. To this Heteroclite are commonly referred the several species of *Bread Corn*, *Gourds*, *Citrals*, *Cucumbers*, &c. Whose materials though crass, are not yet terrene, dry and adstrictive; but diluted with a plentiful portion of aqueous moisture, not exquisitely permixt, because of the small allowance of heat to their Composition.

Art. 4 An Examination and brief redargution of the same Doctrine.

Now (to pass from the faithful Abridgment to the æquitable *Examen* of this Doctrine, of such sacred estimation in the Schools.) though the Enquiries of most have steered this course, directed by the Chart of *Aristotle*, and attempted the deduction of all Sapours from *Primitive Qualities*: yet have they missed the Cape of truth. For, as *Scaliger* (*in lib. de Plantis.*) excellently argues, we may as safely derive Life, Sense, Increment, voluntary Motion, nay Risibility and Intellection (actions flowing from Forms more noble and semi-divine) from Elements immediately, as Sapours from their First Qualities: unless it can be first evinced, that each Element hath some sapour actually inexistent; which but barely to suppose, is an absurdity gross enough to degrade the owner from the dignity of a Physiologist forever; and openly repugnant to the Fundaments of the *Aristotelean* Philosophy. To which argument of *Scaligers*, we shall superadd this weighty exception of our own; that according to the Hypothesis of First Elemental Qualities, it is absolutely impossible to Explicate the Causes of that so great Diversity of Tasts not only among Animals of different species, but Individuals of the same species; of which we shall discourse more expressly in opportunity.

Art. 5. The postposition thereof to the more verisimilous Determination of the sons of *Hermes*, who adscribe all Sapours to *Salt*.

Wherefore we account it both more honourable and satisfactory, to incline rather to that laudable opinion of the Chymist, whose Flames have so farr enlightned our reason, as to shew, that the *Primary Cause* of Sapours doth consist in *Salt*; because all pyrotechnical Dissolutions seem to establish that Axiome, *Sal est primum Sapidum & Gustabile, & omnia quæ saporem habent, eam propter salem habent; ubicunque enim sapor deprehenditur, ibi sal est, & ubicunque sal, ibi sapor*: as the judicious *Sennertus* hath observed (*de Consensu Chymicorum cum Galenic. cap.* 11.) and *Lucius Grillus* hath copiously and solidly declared in that elaborate treatise of his, *de Sapore Amaro & Dulci*, to which we remit the farther Curious.

Art. 6. But far more to that most profound and satisfactory Tenent of *Democritus* and *Plato*; which deduceth the Nativity of Sapours from the various Figures and contextures of the minute particles of Concretions.

But, if we would Anatomize the Heart of this Subject, and establish a more exact theory of the *First* Principles of a Sapour; we must consult the Oracles of *Democritus* and *Plato*, which tell us in short, that all *Sapours arise from the minute particles of Bodies, of such determinate Figures and Contextures, as being applied to the tongue, they naturally produce that Affection therein, which we call Gustation*, or Tasting. Of *Democritus* auctority, in this point, no man can justly doubt while *Aristotle* (*de sens. & sensil. cap.* 4.) avoucheth that He [εἰς τὰ σχήματα ἀνάγει τοῦς χυμοῦς] did referr Sapours to Figures: and *Theophrastus*, in a more

more ample descant upon the text, affirms that He defined the particular sorts of Figures, which constitute the particular species of Sapours; in these words, *Rotundas esse, congruaque mole figuras, quæ Dulcem faciant; magnâ figurâ, quæ Acerbum; multangulâ minimèque orbiculari, quæ Acrem; angulatâ distortâ, quæ Salsum; rotundâ, lævi, distortâ, quæ Amarum; tenui, rotundâ, parvâ, quæ Pinguem.* And, what was *Platoes* persuasion, concerning the same Argument, Himsef most perspicuously explains (*in Timæo*) where He in short adscribes the production of all Sapours [τραχύτησι τὲ, ᾳ λεότησιν] to *Asperity* and *Lævity*: and distinguishing all Sapours into two general orders, the First a *Pleasant* or Sweet sort, the other an *Unpleasant*, which runs up into several branches (for as it stands opposed to Sweet, it is either Bitter, or Salt, or Acid, or Acerb, or Acer, or Austere, &c.) He derives the *First* kind from hence, that the sapid object consists of particles so configurate, that effused upon the organ of Tasting, and entering the small pores or receptaries thereof, they become symbolical or correspondent to its small particles in figure and contexture, and so affect it gently, evenly, and concordantly; and the *Latter* from hence, that the sapid object is composed of such Particles, as have their Figures and Contexture so disproportionate and incommensurable to the pores and particles of the tongue, that invading it and entering its contexture, they exasperate, corrade and offend the same. And hence was it, that *Lucretius* seems to have borrowed his,

Ut facilè agnoscas, è lævibus atque rotundis
Esse ea, quæ sensus jucunde tangere possunt:
At contra, quæ amara, atque aspera cunque videntur,
Hæc magis hamalis inter se cumque teneri;
Proptereaque solere vias rescindere nostris
Sensibus, introituque suo perrumpere corpus.

Art. 7. The *advantages* of this sentence, above all others touching the same subject.

And this is the opinion to which we have espoused our constant assent, as well upon the obligation of those Reasons formerly alledged, in our *Original of Qualities*; as upon this important Consideration, that no other Hypothesis can afford a satisfactory Reason either of *manner* of the Sapours moving and affecting the sensory, or why there is such infinite *Variety* of Tasts not only among Animals of different Species, but even in individuals of the same Species, and particularly in men, among whom Millions are found, who delight in Wormwood, and abhorr Sugar; some that feast their Pallates with Aloes; others that think their mouths quite out of taste, unless they be ruminating the leaves of Tobacco; nay, we have known a Noble person of our own Nation, who had so singular a Pallate, that whenever He took a Purging Potion, would swallow it down by spoonfuls, as judging the pleasure too great to be shortned by a hasty draught, and when twas wholly exhausted, would wish himself a Ruminating Animal, that so He might taste it over and over, as if *Philoxenus* wish for a Cranes neck were too short to reach the height of so desireable a delight; and another, who would not be persuaded but the Forbidden Fruit was a Coloquyntida Apple, because he thought the taste of that the most Ambrosiack of all others.

But,

But, conceding with *Democritus* and *Plato*, that the Variety of Sapours is caused meerly by the Diversity of Impressions on the spongy substance of the Tongue, respective to the various Figures and Contextures of the minute Particles of Bodies applied thereto, and by the salivous moisture thereof so admitted into the pores, as sensibly to affect it: we say, conceding this, we soon may solve this *Dissimilitude* of Tastes, only by saying, that because the Contexture of the particles of the tongue of one man, is different from that of the particles of another; therefore doth one delight in the savor of one thing, the other of another: every man being of necessity most pleased with the taste of that, whose particles in figure and contexture are most symbolical or Correspondent to the Figures and Contexture of the Particles of his tongue; and *è contra.* To which we shall only add, that the Reason why to men in Feavers the sweetest things seem bitter, is only this; that the Contexture of the Particles of the Tongue being altered, as well by the intense Heat of the Feaver, as the infusion of a Bilious Humour into the pores thereof: those things, whose Particles being formerly accommodate, appeared in the species of sweetness, are now become asymbolical and inconvenient to the particles of the tongue, and therefore appear Bitter.

*Art.*8. The *Objections* of *Arist.* concisely, though solidly solved.

Nor is *Aristotles* reprehension of *Democritus*, of weight enough to Counter-encline our judgment; his chief *Objections* being rather Sophistical, than Solid, and so no sooner urged than dissolved.

His *First* is of this importance; if the particles of Sapid Objects were Figurate, according to *Democritus* Assumption, then would the sight, as a Sense far more acute in perception, deprehend their various Figures rather than the Taste: but the Sight doth not discern them; *Ergo.*

Which is soon expeded, by *Answering*, that it is not in the jurisdiction of one sense to judge of objects proper to another; nor is the quæstion about the Figures, as they are in themselves, i. e. without relation to the sense, but as they produce such a determinate Effect on the sensory, of which the *Tasting* is the sole and proper Criterion. For Qualities are to be reputed, not so much Absolute and constant Realities, as simple and *Relative Apparencies*, whose Specification consisteth in a certain Modification of the First General Matter, respective to that distinct Affection they introduce upon this or that particular Sense, when thereby actually deprehended.

His *Second* of this. Insomuch as there is a Contrariety among sensible objects of all kinds; but none among Figures, according to that universally embraced Canon, *Figuris nihil esse Contrarium*: if the Diversity of Sapours were derivative from the Diversity of Figures, then would there be no Contrariety betwixt Sapours; but Sweet and Bitter are Contraries; *Ergo.*

Which is soon detected to subsist upon a Principle meerly precarious; for we are yet ignorant of any reason, why we should not account an *Acute* Figure the Contrary to an *Obtuse*; a *Gibbous* the opposite to a *Plane*; a *Smooth* the Antagonist to a *Rough*; an *Angular* the *Antitheton* to a Sphere, &c.

His

His *Third*, and most considerable, of this. Because the variety of Figures is infinite, at least, inassignable; therefore would the variety of Sapours, if their distinct species were dependent on the distinct species of Figures, be æqually infinite: but all the observable Differences of Sapours exceed not the number of Eight, at most; *Ergo.*

Answer; should we allow *Aristotles* distinction of Sapours to be genuine: yet would it not follow, that therefore there are no more *Specifical Subdivisions* of each Genus; because from the various commistions of those Eight Generical Differences one among another, an incomprehensible variety of Distinct Sapours may be produced. Besides, is not that *Sweetness*, which the tongue perceives in *Hony*; manifestly different from that of *Milk?* that of *Sugar* easily discernable from both? that of *Canary* Sack different from that of *Malago?* that of an *Apple* distinguishable from that of a *Plumm?* that of *Flesh* clearly distinct from all the rest? yet doth that Genus of *Sweet* comprehend them all. On the other side, is the *Amaritude* of *Aloes*, *Coloquyntida*, *Rhubarb*, *Wormwood*, &c. one and the same? or the *Acerbity* of *Cherries*, *Prunes*, *Medlars*, &c, identical? no man, certainly, dares affirm it. Why therefore should we not write our names in the Catalogue of those, who conceive as great variety of *Tastes*, as there is of *Sapid objects* in Nature. Or, since the Experiments of Chymistry have made it probable, that all Sapours derive themselves from *Salts*, as from their *Primary Cause*; why may we not concede so many several sorts of salts, and so many possible Commistions of them, as may suffice to the production of an incomprehensible variety of Sapours?

Art. 9. That the *salivous Humidity* of the Tongue serveth to the *Dissolution* and *Imbibition* of the *Salt*, in all Gustables.

And this gives us occasion to observe, that Nature seems to have furnished the Tonge with a certain *peculiar Moisture*, chiefly to this end, that it might have a General *Menstruum*, or Dissolvent of its own, for the eduction of those *Salts* from hard and drye bodies, and the imbibition of them into its spongy substance, that so it might deprehend and discern them.

CHAP.

CHAP. IX.

Of Rarity, Density, Perspicuity, Opacity.

Sect. I.

Art. 1. This *Chapters* right of succession to the former.

Having thus steered through the deepest Difficulties touching the proper objects of the other Senses, the Chart of Method directs us in our next course to profound the particular natures of all those *Qualities*, which belong to the apprehensive jurisdiction of the Sense of Touching, either immediately, or relatively. But, before we weigh Anchor, that we may avoid the quicksands of too *General Apprehensions*, and draw a Map or Scheme of all the *Heads* of our intended Enquiries; that so we may præpare the mind of our Reader to accompany us the more easily and smoothly: it is requisite that we advertise,

Art. 2. The Divers acceptation of the term, *Touching.*

(1) That the Attribute of *Touching* is sometimes in *Common* to *all Bodies*, as well Inanimate, as Animate, when their superficies or extremes are Contingent; according to that Antithesis of *Lucretius*, *Tactus Corporibus cunctis, intactus Inani.* Sometimes in Common to *all Senses*, insomuch as all Sensation is a kind of Touching, it being necessary, that either the object it self immediately, or some substantial Emanation from it, be contingent to the Sensory; as we have apodictically declared in our præcedent considerations of Visible, Audible, Odorable, and Gustable Species. Sometimes (and in præsent) *Proper* to the *Sense of Touching in Animals*; which, however it extend to the Perception of Objects, in number manifold, in nature various and frequently even repugnant (whereupon some Philosophers have contumaciously contended for a Plurality of Animal Touchings; others gone so high as to constitute as many distinct Powers of Touching, as there are [διαφορὰ, καὶ ἐναντιώσεις κατὰ τὰ ἁφῶ] Differences and Contrarieties of conditions in Tangibles) doth yet apprehend them all under one and the same common reason, and determinate qualification, after the same manner, as the sight discernes White, Black,

Black, Red, Green, &c. all *sub communi Coloris ratione*, in the common capacity of Colours.

Art. 3. A pertinent (though short) Panegyrick on the *sense* of *Touching*.

And this is that fertile sense, to whose proper incitement we owe our *Generation*; for, had not the Eternal Providence endowed the Organs official to the recruit of mankind, with a most exquisite and delicate sense of Touching, the titillation whereof transports a man beyond the severity of his reason, and charmes him to the act of Carnality; doubtless, the Deluge had been spared; for the First age had been the Last, and Humanity been lost in the grave, as well as innocence in the fall of our first Parents. *Quis enim, per Deum immortalem, concubitum, rem adeo fædam, solicitaret, amplexaretur, ei indulgeret? quo Vultu Divinum illud Animal plenum rationis & consilii, quem vocamus Hominem, obsænas mulierum partes, tot sordibus conspurcatus attrectaret, nisi incredibili voluptatis æstro percita essent Genetalia?* And let us but abate the temptation of this sense, and libidinous invitement of it præambulous to the act of Congression; and we shall soon confess that so magnified delight of sensuality, to be no other than what the noblest of Stoicks, *Marcus Antoninus* defined it, Ἔντερίου παράτριψις, καὶ μετὰ τίνας σπασμοῦ μυξαρίου ἔκκρισις, but the attrition of a base entrail, and the excretion of a little snivel, with a kind of convulsion, as *Hippocrates* describes it, This is that *Fidus Achates*, or constant friend, that conserves us in our first life, which we spend in the dark prison of the womb; ushers us into this, which our improvidence trifles away for the most part on the blandishments of sensual Appetite; and never forsakes us, till Death hath translated us into an Eternal one. For when all our other unconstant senses perish, this faithful one doth not abandon us, but at that moment, which determines our mortality. Whence *Aristotle* drew that prognostick (*de Anim. lib. 3. cap. 13.*) "that if any Animal be once deprived of the sense of "Touching, death must immediately ensue; for neither is it possible "(saith He) that any living Creature should want this sense, nor to the be-"ing of it is it necessary that it have any other sense beside this. In a word, this is that persuasive sense, and whose testimony the wary *Apostle* chose to part with his infidelity, and to conclude the presence of his revived Lord. That painful sense, on the victory of whose torments the patient souls of Martyrs have ascended above their faith. That Virtual and Medical sense, by which the *Great Physician of diseased nature*, was pleased to restore sight to the blind, agility to the lame, hearing to the deaf; to extinguish the Feaver in *Peters* Mother-in-Law, stop the inveterate issue in his Hæmorhoidal Client; unlock the adamantine gates of death, and restore the widows son from the total privation, to the perfect habit of life.

Art. 4. Some Tactile Qualities, in common to the perception of other senses also.

(2) That some Qualities are sensible to the Touch, which yet are common to the perception of other senses also; for no scholler can be ignorant of that Division of sensibles into *Common* and *Proper*; and that among the *Common* are reckoned *Motion*, *Quiet*, *Number*, *Figure*, and *Magnitude*, according to the list of *Aristotle* (2 *de Anim. cap. 6.*)

Art. 5. A *Scheme* of all Qualities, or Commonly, or Properly appertaining to the Senſe of Touching; as they ſtand in their ſeveral Relations to, or Dependencies on the Univerſal Matter, Atoms: and ſo, of all the ſubſequent *Capital Arguments* to be treated of, in this *Book*.

(3 and principally) That the Qualities of Concretions, either Commonly or Properly appertaining to the ſenſe of Touching, are to be conſidered in their ſeveral *Relations* to the Principles on which they depend. Firſt, ſome reſult from the Univerſal matter, Atomes, in this reſpect, that they intercept Inanity, or ſpace betwixt them; and of this original are *Rarity* and *Denſity*, with their Conſequents, *Perſpicuity* and *Opacity*. Secondly, Some depend on the Common Materials, in this reſpect, that they are endowed with their three eſſential Proprieties, Magnitude, Figure, Motion: and that either Singly, or Conjunctly. (1) Singly, and either from their Magnitude alone; of which order is the *Magnitude* or Quantity of any Concretion; and the Conſequents thereof, *Subtility* and *Hebetude*: or from their Figure alone, of which ſort is the *Figure* of every thing; and the Conſequents thereof, *Smoothneſs* and *Aſperity*, &c. or only from their Motive Virtue, of which kind is the *Motive Force* inhærent in all things in the General, and that which aſſiſteth and perfecteth the ſame in moſt things, the *Habit* of Motion, and particularly *Gravity* and *Levity*. (2) Conjunctly, from them all; of which production are thoſe commonly called the Four Firſt Qualities, *Heat*, *Cold*, *Dryneſs*, *Moyſture*; as alſo thoſe which are deduced from them, as *Hardneſs*, *Softneſs*, *Flexility*, *Ductility*: and all others of which *Ariſtotle* ſo copiouſly (but ſcarce pertinently) treateth in his fourth book of Meteors: and laſtly, thoſe by vulgar Phyſiologiſts named *Occult Qualities*, which are alſo derivative from Atoms, in reſpect of their three eſſential Proprieties; and among theſe the moſt eminent and generally celebrated, is the *Attractive Virtue* of the Loadſtone.

Art. 6. The right of *Rarity* and *Denſity*, to the Priority of conſideration.

Now on each of theſe we intend to beſtowe particular ſpeculation, allowing it the ſame order, which it holds in this ſcheme, which ſeems to be only a faithful Tranſſumpt of the method of Nature: and we ſhall begin at *Rarity* and *Denſity*. (1) Becauſe nothing can be generated but of Atoms commixt, and that Commixture cannot be without more or leſs of the Inane ſpace intercepted among their ſmall maſſes; ſo that if much of the Inane ſpace be intercepted among them, the Concretion muſt be Rare, if little, Denſe, of meer neceſſity: (2) Becauſe, the Four Firſt reputed Qualities, Heat, Cold, Dryneſs, Moyſture, are poſterior to Rarity and Denſity, as appears by that of *Ariſtotle* (*phyſic* 8.*cap*.16.) where, according to the interpretation of *Pacius*, He intimates, that Heat and Cold; Hardneſs and Softneſs are certain kindes of Rarity and Denſity; and therefore we are to ſet forth from them, as the more Common in Nature, and conſequently the more neceſſary to be known, *à Generalioribus enim, tanquam notioribus ad minus Generalia procedendum*, is the advice of *Ariſt*. (*phyſic*.1.*cap*.2.)

Sect.

SECT. II.

Art. 1. The Opinion of thoſe Philoſophers, who place the Reaſon of Rarity, *in the actual Diviſion of a Body into ſmall parts*; and the brief *Refutation* thereof.

CONcerning the immediate *Cauſes* of Rarity and Denſity in Bodies, divers Conceptions are delivered by Philoſophers. (1) *Some*, obſerving that Rare bodies generally are leſs, and Denſe more Ponderous, and that the Diviſion of a body into ſmall parts, doth uſually make it leſs ſwift in its deſcent through aer or water, than while it was intire; have thereupon determined the Reaſon of *Rarity* to conſiſt *in the actual diviſion of a body into many ſmall parts*: and, on the contrary, that *of Denſity to conſiſt in the Coadunation or Compaction of many ſmall parts into one great continued maſs*. But, Theſe conſidered not, that Chryſtal is not more rare, though leſs weighty (proportionately) than a Diamond: nor that the Velocity of bodies deſcending, doth not encreaſe in proportion to the difference of their ſeveral Denſities; as their inadvertency made them præſume; there being ſundry other Cauſes, beſides the Denſity of a body, aſſignable to its greater Velocity of motion in deſcent, as the Heroical pen of *Galileo* hath clearly demonſtrated (*in* 1. *Dialog. de motu.*) and our ſelves ſhall profeſſedly evince in convenient place.

Art. 2. A ſecond Opinion, deriving Rarity and Denſity *from the ſeveral proportions, which Quantity hath to its ſubſtance*; convicted of incomprehenſibility, and ſo of inſatisfaction.

(2) *Others*, indecently leaping from Phyſical to Metaphyſical ſpeculations, and imagining the ſubſtance of a body to be a thing really diſtinct from the Quantity thereof; have derived Rarity and Denſity *from the ſeveral proportions, which Quantity hath to its ſubſtance*; as if in Rarefaction a Body did receive no mutation of Figure, but an Augmentation, and in Condenſation a Diminution of its Quantity. But the exceſſive ſubtility, or rather abſolute incomprehenſibility of this Diſtinction, doth evidently confeſs it to be meerly Chimerical, as we have formerly intimated, in our diſcourſe concerning the proper and genuine notions of *Corporiety and Inanity*.

Art. 3. A Third, deſuming the more and leſs of Rarity in Bodies, from the more and leſs of VACUITY intercepted among their particles: and the Advantages thereof above all others, concerning the ſame.

(3) A *Third* ſort there are, who having detected the incompetency of the firſt opinion, and abſolute unintelligibility of the Second; judiciouſly deſume the more or leſs of Rarity in any body, from *the more or leſs of Vacuity intercepted among the parts thereof*; *and on the contrary, the more or leſs of Denſity from the greater or leſs excluſion of Inanity, by the reduction of the parts of a body to mutual Contingency*. And this is that opinion, which only hath ſubjugated our judgement, and which ſeems worthy our beſt patronage: in regard not only of its ſufficiency to explicate all the various Apparences among bodies, reſulting from their ſeveral Differences in Rarity and Denſity; but alſo of its exuperance of reaſon above the Firſt, and of intelligibility above the ſecond; it being the duety of a Philoſopher, always to prefer Perſpicuity to Obſcurity; plain and genuine notions to ſuch as are abſtracted not farther from matter, than all poſſibility of Comprehenſion.

Art. 4. The *Definitions* of a *Rare*, and of a *Denſe* Body; according to the aſſumption of a *Vacuity Diſſeminate.*

According to this Hypotheſis, therefore, of Vacuities interſperſed (of which *Epecurus* ſeems to have been the Author) we underſtand, and dare define a *Rare* Body to be ſuch, *as obtaining little of Matter, poſſeſſeth much of Place*; and on the contrary, a *Denſe* one to be that, *which obtaining much of Matter, poſſeſſeth little of Place:* intending by *Place*, all that ſpace circumſcribed by the ſuperfice of the Ambient, ſuch as is the ſpace included betwixt the ſides, or in the concave of a veſſel.

Art. 5. The *Congruity* of thoſe Definitions, demonſtrated.

For, ſuppoſing any determinate ſpace to be one while poſſeſſed by Aer alone, another while by Water alone; the Aer therein contained cannot be ſaid to be Rare, but only becauſe though it hath much leſs of matter, or ſubſtance, yet it takes up as much of ſpace, or room as the Water: nor the Water to be Denſe, but only becauſe though it hath much more of matter, yet doth it take up no more of ſpace, than the Aer. Whence it is purely Conſequent, that if we conceive that Water to be rarified into Aer, and that Aer to be condenſed into Water; the Aer made of the Water rarified, muſt repleniſh a veſſel of capacity not only ten-fold, as *Ariſtotle* inconſiderately conjectured, but a hundred-fold greater, as *Merſennus* by ſtalick experiments hath demonſtrated: and tranſpoſitively, the Water made by the Aer condenſed, muſt be received in a Veſſel of capacity an hundred-fold leſs; when yet in that greater maſs of Aer, there can be no more of Matter, or Quantity, than was in that ſmaller maſs of Water, before its Rarefaction; nor in that ſmaller maſs of Water leſs of Matter, or Quantity, than was in that greater maſs of Aer, before its Condenſation. Evident it is, therefore, that by thoſe, contrary motions of *Rarifaction* and *Condenſation*, a Body doth ſuffer no more than the meer *Mutation of its Figure*, or the *Diffuſion* and *Contraction* of its parts: its Quantity admitting no Augmentation in the one, nor Diminution of the other.

Art. 6. That Labyrinth of Difficulties, wherein the thoughts of Phyſiologiſts have ſo long wandered; reduced to a point, the genuine ſtate of the *Queſtion.*

This being Apodictical, the ſole Difficulty that requires our Enodation, is only this; Whether a Rare Body poſſeſſing a greater ſpace, than a Denſe, proportionately to its Quantity, doth ſo poſſeſs all that ſpace circumſcribed by its ſuperfice, as to repleniſh all and every the leaſt particle thereof, not leaving any ſpace or ſpaces, however exile, unrepleniſht with ſome adæquate particle of its matter? Or whether there are not ſome ſmall parts of ſpace, intermixt among its diffuſed or mutually incontingent particles, in which no particles of its matter are included, and ſo there remain ſmall Vacuola, or Empty ſpaces, ſuch as we have formerly more than twice deſcribed, in our Chapter of a Diſſeminate Vacuity in Nature?

And this deſcends into another Doubt, whoſe clear ſolution is of ſo much importance, as richly to compenſate our moſt anxious Enquirie; *viz.* Whether Rarity be cauſed from the interception of much Inanity, when the parts of a Body, formerly Adunate, are ſeparated each from other (at leaſt, in ſome points of their ſuperfices) and ſo the Body become ſo much more Rare, by how much the more, or more ample empty ſpaces are intercepted among its incontingent particles: or Whether Denſity and Rarity depend on any other poſſible Cauſes beſides this, i. e. without the intermiſtion of inane ſpaces among the particles of Bodies? And this we conceive to be the whole and

and true ſtate of that Controverſie, which hath ſo perplexed the minds of many the moſt eminent Philoſophers in the world.

Art. 7. That *Rarity* and *Denſity* can have no other Cauſes immediate, but the *more* and *leſs of Inanity* interſperſed among the particles of Concretions; DEMONSTRATED

That the Rarity and Denſity of Bodies can ariſe from no other Cauſe immediately, but the more or leſs of Inanity intercepted among their particles; may be thus *Demonſtrated.*

If in a Rare body there be admitted no *Vacuola*, or ſmall empty ſpaces, but it be aſſumed, that the particles of Matter are adæquate both in Number and Dimenſions to the particles of ſpace, wherein it is contained; then muſt it neceſſarily follow, that in Condenſation many particles of Matter muſt be reduced into one particle ſpace, which before Condenſation was adæquate onely to one particle of Matter: and, on the contrary; in Rarefaction, one and the ſame particle of matter muſt poſſeſs many of ſpace, each whereof, before Rarefaction, was in dimenſions fully reſpondent thereto. For Example; in Aer condenſed into Water, an hundred particles of Aer muſt be reduced into one particle of ſpace: and in Water rarified into Aer, one particle of the matter of Water muſt poſſeſs an hundred particles of ſpace. Again, according to the Aſſumption of no Vacuity, ſince in a Veſſel replete with Aer, the parts of Aer muſt be equal in number and dimenſions to the parts of ſpace, thereby circumſcribed, none the leaſt particle of ſpace being admitted to be Inane; if you fill the ſame Veſſel with Water, or Lead, or Gold, it muſt follow, that the parts of the matter of Aer, and the parts of the matter of Water, Lead, or Gold, ſhall be equal in number, becauſe *Quæ ſunt uni tertio æqualia; æqualia ſunt etiam inter ſe:* and if ſo, needs muſt Aer be æqually Denſe with Water, Lead, or Gold, which all men allow to be the moſt denſe and compact body in Nature in regard it tranſcends all others in weight and difficulty of Solution, or Diviſion;

(2) All bodies in the Univerſe muſt be equally Denſe, or equally Rare;

(3) And ſo nothing can be capable of Condenſation or Rarefaction. The leaſt of which unconcealable *Abſurdities*, (not to enumerate any others of thoſe many that depend on the ſame Conceſſion of an abſolute Plenitude, or no Vacuity) is great enough to render thoſe Heads, which have laboured to deſtroy the *Vacuola* of *Epicurus*, ſtrongly ſuſpected of Incogitancy, if not of ſtupidity.

Art. 8. *Ariſtotles* Exceptions, againſt Diſſeminate Inanity; neither important nor competent.

Twere good manners in us to præſume, that no man can be ſo Facile, as to conceive, that *Ariſtotle* hath prevented theſe *Exceptions*, by that Diſtinction of his, *de Actu & Potentia*: but, becauſe Præjudice may do much, we judge it expedient a while to inſiſt upon the Examination of the *importance* and *congruity* thereof. He ratiocinates (4 *phyſic.cap* 9.) *that the matter of Contraries, E. G. of Heat and Cold, Rarity and Denſity is one and the ſame; ſo that as the ſame matter is one while Actually Hot another while Actually Cold, becauſe it is both Hot and Cold Potentially: ſo is one and the ſame matter now Actually Rare, now Actually Denſe, becauſe it is both Rare and Denſe Potentially.* But, in ſtrictneſs of Logick, all that this Argument enforceth, is only that the ſame matter

is

is Capable of Rarefaction and Condenſation; which no man ever diſputed. The Quæſtion is, Whether the ſame Matter, when Actually Rare, hath its parts diſſociated and diffuſed into a greater ſpace, than what they poſſeſſed while it was onely Potentially Rare, and that without the intermixture of Inanity among them? And all that can be collected from his diſcourſes touching that, is no more than this; that *as a matter or ſubſtance actually Hot, doth become more Hot, without the Emerſion, or Acceſsion of any new part, which was not actually Hot before: ſo likewiſe doth the ſame matter actually Extenſe, become more Extenſe, without the Emerſion, or Acceſsion of any new part, which was not actually Extenſe before.* But this Arrow was ſhot at random, not directly to the mark, nor hath it attained the Difficulty; For the Quæſtion again is not, Whether in Rarefaction, any part of the matter were not formerly Extenſe: but, Whether that matter, which was formerly Extenſe, can be made more Extenſe without the Diſſociation of its particles; and whether the particles of it can be actually Diſſociated, without the interception of Inanity among them? Beſides, His *Compariſon* is as incongruous, as his Argument is weak; for (1) His Aſſumption concerning Heat is not only Precarious, but falſe, as ſhall be demonſtrated, *in ſuo loco:* (2) were it true, yet doth that part of matter, which is actually Hot, remain indivulſe or indiſtracted; otherwiſe than a part of matter, which being actually Extenſe, becomes more Extenſe, and therefore the Analogy faileth.

In concluſion, to mend the matter, He recurrs to that ſimilitude of a *Circle, which though contracted into a leſs, hath yet none of its parts more incurvate than they were before:* But, alas the Quæſtion ſtill remains untoucht, and (that we may not ſtay to impeach him of indecorum, in making an indecent tranſition from a Phyſical to a Mathematical ſubject; contrary to his own Dialectical inſtitutes) his ſimilitude will bear no more of inference but only this, that a thing may be made more Denſe, which is Rare and Lax; which is impertinently diſputed; when all men concede it.

Art. 9. The Hypotheſis of a certain *Æthereal* ſubſtance, to repleniſh the pores of Bodies, in Rarifaction; demonſtrated inſufficient, to ſolve the Difficulty, or demoliſh the *Epicurean* Theſis of ſmall Vacuities

The *Advocates* of *Ariſtotle* generally alleage in his Defence, that He ſuppoſed a certain *Æthereal*, or as ſome have called it, *Animal* ſubſtance, which inexiſtent in all Bodies, doth repleniſh their pores, and more eſpecially if their Contexture be Rare; and that when a Denſe Bodie is rarified, there are no ſmall Inane ſpaces intercepted among its Diſſociated particles, but that the ſpaces betwixt them are immediately poſſeſſed by that ſubtile Æthereal ſubſtance: and that when a Rare Body is Condenſed, that Æthereal ſubſtance, which did repleniſh its pores, is excluded.

But this *ſuppoſition*, though it come neerer to the Quæſtion, or center of the Difficulty, is yet far ſhort of *ſolving* it. For, take we (for Example) a Cubical foot of Aer, and inſomuch as the ſubſtance of the Aer is more groſs, or leſs exile, than the ſubſtance of the ſuppoſed Æther, therefore muſt it conſiſt of fewer particles, than the Æther: and upon conſequence, in the whole Cubical foot of Aer there are not more particles of Matter, the Aereal and Æthereal ones being conjoyned, than if it conſiſted only of Aereal particles. Now we enquire of *Ariſtotles* Champions

pions. Whether or no in that Cubical foot consisting of the Aggregate of both sorts of particles, there are as many particles of Matter, as are in a Cubical foot of Water, Lead, or Gold? The *Affirmative* is more than they dare own; nor can they deny, but that the space possessed by one foot containeth as many small parts of space, respondent to the particles of matter, as the other: and if so, must not there be in the Foot of Aer, many particles of space, which are possessed neither by the Aereal nor Æthereal particles, and are not those unpossessed particles of space absolutely Empty? If you undertake the *Negative*, you insnare your self in this Absurdity, that the particles of a Cubical Foot of Aer and Æther conjoyned, must be equal in number to the particles of a Cubical foot of Water, Lead, or Gold.

Art. 10. The *Facility* of understanding the Reasons and Manner of Rarifaction and Condensation, from the Concession of small Vacuities; illustrated by a congruent *Similitude*.

The Difficulty of understanding the Formal and Immediate Reason of Rarity and Density in Bodies, by that so popularly applauded Hypothesis of an *Æthereal substance* (imagined to maintain an absolute Plenitude, and so a Continuity through the whole vast Body of Nature) being thus evinced; let us a while consider, how easily even the meanest Capacity may comprehend the full Nature of those Primary and Eminent Affections, from the concession of *small Vacuities*. We have formerly explicated the matter, by the convenient similitude of an Heap of Corn, or Sand; which being lightly and gently poured into a Vessel, takes up more room then when prest down: and we shall yet more facilitate the Conception thereof by another simile, somewhat more prægnant, because more Analogous. When a *Fleece*, or *Lock of Wool* is deduced, or distended, we say, it is made more Rare; and when Compressed, more Dense: now the Rarity thereof consisteth only in this, that the Hairs, which were formerly more Consociate, United, or at closer Order among themselves, are Dissociated, Dis-united, or reduced to more open Order, and the spaces betwixt them, become either more, or larger, in which no particle of Wool is contained: and on the contrary, the Density thereof consisteth onely in this, that the Particles or Hairs, which were before more Dissociated, or at open order, are by Compression brought to more Vicinity, or to closer order, and the spaces betwixt them become fewer and lesser. And thus are we to conceive, how the same Matter, without Augmentation or Diminution of Quantity, may be now Rarified into Aer, and anon Condensed into Water; for, instead of the Hairs in the Fleece of Wool, we need only put the Particles of the matter, which in Rarifaction are Dissociated, in Condensation Coadunated. And this Conception may be extended also to a Spunge, Flaxe, or any other Porous and Lax bodie; because they are capable of Expansion and Contraction onely in this respect, that the small spaces intercepted in the incontiguities or distances of their particles, are now enlarged, now contracted. We confess, this similitude is not adæquate in all points, there being this *Difference*, that when a Fleece of Wool is expanded, the ambient Aer doth instantly insinuate into the small spaces intercepted betwixt the dissociated particles of it, and so possess them; but, nothing of Aer, or Æther, or other substance whatever doth insinuate it self into the small spaces intercepted betwixt the dissociated particles of Aer, or Water, when either of them is Rarified: we say, notwithstanding this Disparity,

Diſparity, yet doth it hold thus far good and quadrant, that as nothing of Wool poſſeſſeth thoſe ſpaces, which would therefore remain abſolutely Empty, in caſe the ſociable Aer did not inſtantly ſucceed in poſſeſſion of them; ſo, ſince the parts of the matter of Water are Expanſed or Diſſociated after the ſame manner, as are the Hairs of Wool, and after the ſame manner Contracted or United; and certain ſmall Loculaments are likewiſe intercepted betwixt the particles of that matter, in which nothing of Water can be contained, during the ſtate of Rarifaction, and which no other ſubſtance can be proved to poſſeſs; it muſt thence follow, that thoſe deſerted ſmall ſpaces, or Loculaments remain abſolutely Empty. And more than that, our ſimilitude is not concerned to impart.

Art. 11. PARADOX. That the Matter of a Body, when Rarified, doth poſſeſs no more of true Place, than when Condenſed, and the *Conciliation* thereof to the præpoſed Definitions of a Rare and of a Denſe Body.

But, that we may make ſome farther advantage thereof, we obſerve; that as when a Fleece of Wooll is expanſed, it is of a greater circumference, and ſo includes a greater Capacity therein, than when it is compreſſed; not that the ſingle Hairs thereof take up a greater ſpace in that capacity, for no Haire can poſſeſs more ſpace, than its proper bulk requires, but becauſe the inane ſpaces or Loculaments intercepted betwixt their diviſions are enlarged: exactly ſo, when the ſame Matter is now Rarified into Aer, anon Condenſed into Water, the Circumference thereof becomes greater and leſs, and the Capacity included in that circumference is augmented and diminiſhed accordingly; not that the ſingle Particles of the Matter poſſeſs a greater part of that capacity in the ſtate of Rarifaction, than in that of Condenſation, becauſe no particle can poſſeſs more of ſpace than what is adæquate to its dimenſions; but only becauſe the Inane ſpaces intercepted betwixt their diviſions are more ample in one caſe, than in the other. And hence it is purely conſequent, *that the matter of a Body Rarified can not be juſtly affirmed to poſſeſs more of true or proper Place, than the matter of the ſame body Condenſed*; though, when we ſpeak according to the cuſtomary Dialect of the Vulgar, we ſay, that a Body Rarified doth poſſeſs more of ſpace, than when Condenſed: inſomuch as under the terme Place is comprehended all that Capacity circumſcribed by the extremes or ſuperfice of a Body; and to the Matter, or Body it ſelf are attributed not onely the ſmall ſpaces poſſeſſed by the particles thereof, but alſo all thoſe inane ſpaces interjacent among them, juſt as by the word *City*, every man underſtands not only the dwelling Houſes, Churches, Caſtles, and other ædifices, but alſo all the ſtreets, Piazzaes, Church-yards, Gardens, and other void places contained within the Walls of it. And in this ſenſe onely are our præcedent *Definitions* of a *Rare*, and *Denſe* Body to be accepted.

Art. 12. PROBLEM. Whether Aer be capable of Condenſation to ſo high a rate as it is of Rarifaction: and the Apodictical *ſolution* thereof.

The Reaſons of Rarity and Denſity thus evidently Commonſtrated, the pleaſantneſs of Contemplation would invite us to advance to the examination *of the ſeveral Proportions of Gravity and Levity among Bodies, reſpective to their particular Differences in Denſity and Rarity; the ſeveral ways of Rarifying and Condenſing Aer and Water; and the means of attaining the certain weights of each, in the ſeveral rates, or degrees of their Rarifaction and Condenſation;*

sation; according to the evidence of Aerostatick and Hydrostatick Experiments: but in regard these things are not directly pertinent to our present scope and institution, and that *Galilæus* and *Mersennus* have enriched the World with excellent Disquisitions upon each of those sublime Theorems; we conceive ourselves more excusable for the Omission, than we should have been for the Consideration of them, in this place. However, we ask leave to make a short Excursion upon that PROBLEM, of so great importance to those, who exercise their Ingenuity in either *Hydraulick*, or *Pneumatick* Mechanicks: *viz.*

Whether may Aer be Rarified as much as Condensed; or whether it be capable of Rarifaction and Condensation to the same rate, or in the same proportion?

That common Oracle, for the Solution of Problems of this abstruse nature, Experience hath assured, that Aer, may be Rarified to so great a height, in red-hot Æolipiles, or Hermetical Bellows; that the 70 part of Aer formerly contained therein, before rarifaction, will totally fill an Æolipile upon extreme Rarifaction thereof. For, *Mersennus*, using an Æolipile, which being Cold, would receive exactly 13 ounces, one Drachm and an half; and when Hot, would suck in only 13 ounces: found, that the whole quantity of Aer ignified, and replenishing the same Æolipile, when glowing Hot, being reduced to its natural state, did possess only the 70. part of the whole Capacity, which was due to the Drachm and half of Water. We say, upon *Extreme* Rarifaction; because this seems to be the highest rate, to which any Rarifaction can attain, in regard the Metal of the Æolipile can endure no more violence of the Fire, without Fusion.

As for the Tax, or Rate of its utmost *Condensation*; though many are persuaded, that Aer cannot be reduced, by Condensation, to more than a Third part of that Space, which it possesseth in its natural state; because they have observed, that Water infused into a Vessel of three Heminæ, doth not exceed two Heminæ, in regard of the Aer remaining within: yet certain it is, that Aer may be Condensed to a far higher proportion. For, Experience also confirms, that into the Chamber of a Wind-Gun (of usual Dimensions) Aer may be intruded, to the weight of a Drachm, or sixty Grains: and that in that Capacity, which contains only an ounce of Water, it may be so included, as that yet a greater proportion of Aer may be injected into it. Now, therefore, insomuch as the Aer in *Mersennus* his Æolipile amounts to four Grains (at least) or sixe (at most) which number is ten times multiplied in sixty; and that the Concave of the Æolipile is to the Concave of the Pipe of the Wind-Gun, in proportion sesquialteral: by Computation it appears, that the Aer condensed in the Chamber of the Wind-Gun must be sufficient to fill the Æolipile ten times over, or the same Chamber 15 times over, if restored to its natural tenour. And hereupon we may safely Conclude, that Aer may be Compressed in a Wind-Gun, to such a rate, as to be contained in a space 15 times less, than what it possessed during its natural Laxity; and that by the force only of a Mans hand, ramming down the Embolus, or

Charging Iron: which Force being capable of Quadruplication, the Aer may be reduced into a ſpace ſubquadruple to the former. If ſo, the rate of the poſſible Condenſation of Aer, will not come much ſhort of that of its extreme Rarefaction: at leaſt, if a Quadruple Force be ſufficient to a Quadruple Condenſation; and Aer be capable of a Quadruple Compreſſion: both which are Difficulties not eaſily determinable.

Sect. III.

Art. 1. The *opportunity* of the preſent ſpeculation, concerning the Cauſes of *Perſpicuity* and *Opacity*.

PERSPICUITY and OPACITY we well know to be Qualities not præciſely conformable to the Laws of Rarity and Denſity; yet, inſomuch as it is for the moſt part found true (*cæteris paribus*) that every Concretion is ſo much more Perſpicuous, by how much the more Rare; and *è contra*, ſo much the more Opace, by how much more Denſe; and that the Reaſon of Perſpicuity can hardly be underſtood, but by aſſuming certain ſmall *Vacuities* in the Body interpoſed betwixt the object and the eye, ſuch as may give free paſſage to the viſible Species; nor that of Opacity, but by conceding a certain *Corpulency* to the ſpace or thing therein interpoſed, ſuch as may terminate the ſight: therefore cannot this place be judged incompetent, to the Conſideration of their ſeverall originals.

Art. 2. The true Notions of a *Perſpicuum* and *Opacum*.

By a *Perſpicuum* [τὸ διαφανὲς] we ſuppoſe, that every man underſtands that Body, or Space, which though interpoſed betwixt the Eye and a Lucid, or Colorate Object, doth nevertheleſs not hinder the Tranſition of the Viſible ſpecies from it to the Eye: and by an *Opacum*; that which obſtructing the paſſage of the Viſible Species, terminates the ſight in it ſelf.

Art. 3. That every Concretion is ſo much the more Diaphanous, by how much the more & more ample Inane Spaces are intercepted among its particles; *cæteris paribus*.

We ſuppoſe alſo, that (according to our præcedent Theory) the Species Viſible conſiſt of certain *Corporeal Rayes* emitted from the Object, in direct lines toward the Eye; and that where the Medium, or interjacent ſpace is *free*, thoſe Rayes are delated through it without impediment; but, where the ſpace is præpoſſeſſed by any ſolid or Impervious ſubſtance, they are repercuſſed from it toward their Original, the Object. And hence we inferr, that becauſe the total Freedom of their Tranſmiſſion depends only upon the total Inanity of the Space intermediate; and ſo the more or leſs of freedome trajective depends upon the more or leſs of Inanity in the Space intermediate: therefore muſt every Concretion be ſo much more Perſpicuous, by how much the more, and more ample Inane Spaces it hath intercepted among its Component particles; which permit the Rayes freely to continue on their progreſs home to the Eye.

This we affirm not *Univerſally*, but under the due limitation of a *Cæteris Paribus*, as we have formerly hinted. Becauſe, notwithſtanding a piece of Lawn is more or leſs Perſpicuous, according as the Contexture of its Threads is more or leſs Rare; and the Aer in like manner is more or leſs pellucid, according as it is perfuſed with more or fewer Vapours: yet do we not want Bodies, as *Paper*, *Sponges*, &c. Which though more then meanly Rare, are nevertheleſs Indiaphanous; and on the contrary,

contrary, we see many Bodies, sufficiently Dense, as *Horn*, *Muscovy-glass*, *common glass*, &c. which are yet considerably Diaphanous.

Now, that you may clearly comprehend the *Cause* of this *Difference*, be pleased to hold your right hand before your eye, with your fingers somewhat distant each from other; and then looking at some object, you may behold it through the chinks or intervals of your fingers: this done, put your left hand also over your right, so as the fingers of it may be in the same position with the former; and then may you perceive the object, at least as many parts of it as before. But, if you dispose the fingers of your left hand so as to fill up the spaces or intervals betwixt those of your right; the object shall be wholly eclipsed. Thus also, if you look at an object through a Lawn, or Hair Sieve, and then put another Sieve over that, so as the holes or pores of the second be parallel to those of the first; you may as plainly discern it through both as one: but, if the twists of the second sieve be objected to the pores of the first, then shall you perceive no part of the object, at least so much the fewer parts, by how much greater a number of pores in the first are confronted by threads in the second. And hence you cannot but acknowledge that the Liberty of inspection doth depend immediately and necessarily upon the Inanity of the pores; the Impediment of it upon the Bodies that hinder the trajection of the Rayes emitted from the Object: and yet that to *Diaphanity* is required a *certain orderly and alternate Position of the Pores and Bodies, or Particles.* This considered, it is manifest, that the Reason *why Glass, though much more Dense, is yet much more perspicuous than Paper*, is only this; that the Contexture of the small filaments, composing the substance of Paper, is so *confused*, as that the Pores that are open on one side or superfice thereof, are not continued through to the other, but variously intercepted with cross-running filaments: as is more sensible in the Cohtexture of a *Spunge*, whose holes are not continued quite thorow, but determined at half way, (some more, some less) so that frequently the bottome of one hole is the cover of another, as the Cells in a Hony-comb: but, Glass, in regard of the *uniform and regular Contexture* of its particles, which are ranged as it were in distinct ranks and files, with pores or intervals orderly and directly remaining betwixt them; hath its pores not so soon determined by particles oppositely disposed, but continued to a greater depth in its substance.

Art. 4. Why *Glass*, though much more *Dense*, is yet much more *Diaphanous*, than *Paper*.

Though this make the whole matter sufficiently intelligible, yet may it receive a degree more of illustration, if we admit the same Conditions to be in the substance of Glass, that are in a *Mist*, or Cloud; through which we may behold and object, so long as the small passages or intervals betwixt the particles of the Vapours, through which the rayes of the visible species may be trajected, remain unobstructed: but yet perceive the same so much the more obscurely, by how much the more remote it is; because, in that case, more impervious particles are variously opposed to those small thorow-fares, that obstruct them, and so impede the progress of most of the rayes. For, thus also Glass, if thin, doth hinder the sight of an object very little, or nothing at all; but if very thick, it wholly terminates the progress of the species: and, by how much the thicker it is, by so much the more it obscures the object. And this, only because Glass, consisting of small solid Particles, or Granules, and insensible Pores alternately situate, hath many of its pores running on in direct lines through its sub-

Art. 5. Why the *Diaphanity* of Glass is gradually diminished, according to the various degrees of its *Crassitude*.

ſtance to ſome certain diſtance; but ſometimes theſe; ſometimes thoſe are obturated by ſmall ſolid particles ſuccedent, when at ſuch a determinate *Craſsitude*, it becomes wholly opace.

Art. 6. An Apodictical Confutation of that popular Error, that *Glaſs is totally, or in every particle, Diaphanous.*

And this gives us an opportunity to refute that vulgar *Error*, *That the ſubſtance of Glaſs is totally Diaphanous, or that all and every Ray of the the Viſive Species is trajected through it, without impediment.* To demonſtrate the contrary, therefore, we adviſe you to hold a piece of the fineſt and thinneſt Venice Glaſs againſt the Sun, with two ſheets of white paper, one betwixt the Sun and the Glaſs, the other betwixt the Glaſs and your Eye: for, then ſhall all the *Trajected* Rayes be received on the paper on this ſide of the glaſs, and the *Reflected* ones be received on that beyond it. Now, inſomuch as that paper, which is betwixt your eye and the glaſs, doth receive the *Trajected* rayes, with a certain apparence of many ſmall *ſhadows* intercepted among them; and that paper beyond the glaſs, doth receive the *Reflected* rayes with an apparence of many ſmall *lights*: therefore we demand (1) from whence can that ſpecies of ſmall ſhadows ariſe, if not from the Defect of thoſe rayes, that are not tranſmitted through the Glaſs, but averted from it? (2) Whence comes it, that in neither paper the Brightneſs or Splendour is ſo great, as when no Glaſs is interpoſed betwixt them; if not from hence, that the reflected rayes are wanting to the neareſt, the trajected ones to the fartheſt? (3) Whence comes it that ſome rayes are reflected, others trajected; if not from hence, that as a Lawn ſieve tranſmits thoſe rayes, which fall into its pores, and repercuſſeth others that fall upon its threads: ſo doth Glaſs permit thoſe rayes to paſs through, that fall into its pores; and reverberate thoſe, that ſtrike upon its ſolid particles? And what we here ſay of Glaſs, holds true alſo (in proportion) of *Aer*, *Water*, *Horn*, *Verniſh*, *Muſcovy-glaſs*, and all other *Diaphanous* Bodies.

CHAP.

CHAP. X.

OF

MAGNITUDE, FIGURE:

And their Consequents,

SUBTILITY, HEBETUDE, SMOOTHNESSE, ASPERITY.

SECT. I.

THE MAGNITUDE and FIGURE of Concretions, in regard our Reason doth best derive them from the Two First Proprieties, or Essential Attributes of the Universal Matter, Atoms; are the Qualities which justly challenge our next Meditation. Concerning their Origination, therefore, we advertise

Art. 1. The Contexture of this Chapter, with the præcedent

First, that although it be not necessary, that a Body made up of greater Atoms should therefore be greater, nor contrariwise, that a Body composed of lesser Atoms, should therefore be lesser; nor that a Body consisting of Atoms of this, or that determinate Figure, should constantly retain that Figure, without capacity of determination to any other: yet doth it seem universally true, that every Concretion therefore hath Magnitude, because its Material Principles, or Component Particles have their certain Magnitudes, or are essentially endowed with real Dimensions; and as true, that every Concretion is therefore determined to this or that particular Figure, because the Component Particles thereof are not immense, or devoyd of circumscription, but terminated by some Figure or other.

Art. 2. That the *Magnitude* of *Concretions*, ariseth from the Magnitude of their *Material Principles.*

Secondly, that the term *Magnitude* here used, is not to be accepted in a Comparative intention, or as it stands in opposition to Parvity; in which sense

Art. 3. The præsent intention of the term, *Magnitude.*

sense vulgar ears always admit it: but a *Positive*, or as it is identical and importing the same thing with Quantity, or Extension. For, as every Atom, or that ultimate and indivisible portion of Matter, so called, is no Mathematical point, but possesseth its own simple Magnitude, or Quantity, without respect or comparison to Greater or Less. So must every Concretion be considered, as it stands possessed of its own compound Magnitude, or Quantity, without respect to any other Body, in comparison whereof it may be said to be Greater or Less. Because without the relative conception of any other Body, the Mind doth most clearly and distinctly apprehend the Magnitude of a Concretion by a Positive notion; insomuch it conceives it to have various parts, whereof none are included within other, but all situate in order, and each in its proper place: so that from thence must follow the Diffusion of them, and consequently the Extension of the whole consisting of them. And well known it is, that the Magnitude, or Quantity of a Body, is nothing but that kind of Extension, which amounts from the aggregate of the singular Extensions of its component particles: of which if any be conceived to be Detracted, or Apposed; so much is instantly understood to be Detracted from, or Apposed to the Extension of the whole Body. To this alludes that Distich of *Lucretius*,

Propterea, quia quæ decedunt Corpora quoique,
Unde abeunt, minuunt; quo venere, augmine donant.

Art. 4. That the *Quantity* of a thing, is meerly the *Matter* of it.

This duely perpended, no man need hereafter fear the drilling of his ears by those clamorous and confused litigations in the Schools, about the Formal reason of Quantity; for nothing can be more evident than this, that the Extension or Quantity of a thing is meerly *Modus Materiæ*, or (rather) the *Matter* it self composing that thing; insomuch as it consisteth not in a Point, but hath parts posited without parts, in respect whereof it is Diffuse: and purely consequent from thence, that every Body hath so much of Extension, as it hath of Matter, extension being the proper and inseparable Affection of Matter or Substance. Hence also may we detect and refute the extreme absurdity of those high-flying Wits, who imagine that a Body, when Rarified, though it hath no more of Matter, hath yet more of Quantity or Extension, than when Condensed: because from the præmises it is an apodictical verity, that the Extension attributed to a Body Rarified, is not an Extension of the Matter of it alone, but of the Matter and small Inane Spaces, intercepted among its dissociated particles, together; so that if you suppose the Extension of those small Vacuities to be excluded from the Aggregate, you cannot but confess, that the Matter hath no more of Extension in its parts Dissociated, than it had in the same parts Coadunated.

Art. 5. The *Quantity* of a thing neither augmented by its *Rarefaction*; nor diminished by its *Condensation*: contrary to the *Aristoteleans*, who distinguish the *Quantity* of a Body, from its *Substance*.

Moreover, this sufficiently instructs us to give a decisive Response to that so long debated Quæstion, *An per Rarifactionem acquiratur, per Condensationem deperdatur Quantitas?* Whether the Quantity of a Body is Augmented in Rarifaction, and Diminished in Condensation, or no? For, as nothing of Matter is conceived to be added to a body, while it is Rarified; nothing of Matter detracted from it while Condensed: so is it undeniable, at least unrefutable, that nothing of Quantity is acquired by Rarifaction

or

or amitted by Condenſation; but only that thoſe empty ſpaces are admitted, or excluded, which being in a Rarified body conjoined to the ſmall ſpaces, that the particles of its matter poſſeſs, make it appear to be Greater, or to repleniſh a greater place, than before; and in a Condenſed body, detracted from the ſmall ſpaces, that the particles of its matter do poſſeſs, make it appear Leſs, or to fill a leſs place than before. If ſo, it may be cauſe of wonder even to the wiſeſt and moſt charitable Conſideration, that the Defendants of *Ariſtotles* doctrine of Quantity, have with ſo much labour and anxiety of mind betrayed themſelves into ſundry not only inextricable Difficulties, but open Repugnances; while on the one ſide they affirm, that as well Quantity as Matter, is Ingenerable and Incorruptible: and on the other admit, that the ſame Matter may be one while Extended to the occupation of all and every part of a greater ſpace; and another while again ſo contracted, as to be wholly comprehended in the hundreth part of the former ſpace (as in the Condenſation of Aer into Water) than which no Contradiction can be or more open, or more irreconcileable. And yet we ſee thoſe, who have eaſily ſwallowed it, and upon digeſtion become ſo tranſcendently exalted to ſublimities, as to imagine the Quantity of a thing to be abſolutely diſtinct from the matter, or ſubſtance of it: and thereupon to conclude, that Rarity and Denſity doe conſiſt only in the ſeveral proportions, which ſubſtance hath to Quantity.

Art. 6. The reaſon of Quantity, explicable alſo meerly from the notion of *Place*.

Much more plauſible were their Explication, had they derived the Extenſion of a thing, meerly from *Space*, or *Place*; becauſe, whenever any thing is ſaid to be Extenſe, the mind inſtantly layes hold of ſome determinate part of ſpace, referring the Extenſion of it ſimply and entirely to the Place, wherein it is, or may be contained, and which is exæquate to its Dimenſions: nor is it, indeed, eaſie to wean the Underſtanding from this habitual manner of Conception. Whereof if we be urged to render a ſatisfactory Reaſon, we confeſs, we know no better than this; that by the Law of Nature, every Body in the Univerſe is conſigned to its peculiar Place, i. e. ſuch a canton of ſpace, as is exactly reſpondent to its Dimenſions: ſo that whether a Body quieſce, or be moved, we alwayes underſtand the Place wherein it is Extenſe, to be one and the ſame, i.e. equal to its Dimenſions.

Art. 7. The Exiſtence of a Body, without real Extenſion; & of Extenſion without a Body: though impoſſible to *Nature*, yet eaſie to God.

We ſay, *By the Lay of Nature*; becauſe, if we convert to the Omnipotence of its Author, and conſider that the Creator did not circumſcribe his own Energy by thoſe fundamental Conſtitutions, which his Wiſedom impoſed upon the Creature: we muſt wind up the nerves of our Mind to a higher key of Conception, and let our Reaſon learn of our Faith to admit the poſſibility of a Body exiſtent without Extenſion, and the Extenſion of a Body conſiſtent without the Body it ſelf; as in the ſacred myſtery of our Saviours Apparition to his Apoſtles, after his Reſurrection [τῶν θυρῶν κεκλεισμένων] the dores being ſhut. Not that we can comprehend the *manner* of either, i. e. the Exiſtence of a Body without Extenſion, and of Extenſion without a Body; for our narrow intellectuals, which cannot take the altitude of the ſmalleſt effect in Nature, muſt be confeſt an incompetent meaſure of ſupernaturals: but that, whoever allowes the power of God to have formed a Body out of no præexiſtent matter; cannot deny the ſame power to extend to the reduction of the ſame Body to nothing of matter again. Which the moſt pious S. *Auguſt.* (*Epiſt.* 3.) had

had regard unto, in his excellent Adhortation, *Ut demus Deum aliquid posce, quod nos fateamur investigare non posse, & in quo tota ratio facti sit ipsa potentia facientis.*

Art. 8. COROLLARY. That the primary Cause, why Nature admits no Penetration of Dimensions, is rather the *Solidity*, than the Extension of a Body.

And here we have opportunity to observe, by way of Corollary, that insomuch as every Philosopher considers in a Body as well its *Solidity*, or Corpulency, as *Extension*, or Quantity (though not as things really distinct, yet the same under a twofold acceptation) we say, we therefore observe, that the primary Cause, why Nature cannot endure a *Penetration of Dimensions*, or that two Bodies cannot be admitted into the same place at once, seems not to be the Extension or Quantity of it, præcisely accepted, as the Disciples of *Aristotle* commonly conceive; but its Corpulency, or Solidity. For from this, rather than that, may be understood that *Opposition*, which is betwixt a *Vacuum* and a *Body*: and the *Renitency* which is in one Body against the admittance of another into it self.

Art. 9 The reasons of Quantity *Continued* and *Discrete*, or Magnitude and Multitude.

Concerning the *Continuity* of a Body we also observe; that a Body is to be reputed Continued, in respect its Parts are Copulate, Cohærent and Indivulse among themselves, so that notwithstanding they are in reality no more then mutually Contiguous, yet are their Commissures or conjoinings so exile, as not to be deprehensible by the sense. And thus may we understand Magnitude, or *Quantity Continued* (as the Schools phrase it) to be distinguished from *Quantity Discrete*, or *Multitude*, only by this; that the parts of Magnitude may, indeed, be separated each from other, but are not actually separate: but the parts of Multitude are actually separate. Not that the parts of Multitude may not be mutually contingent (as many stones lying in one heap together) but that they do not reciprocally take hold of, or bind in each other, so as to make a sensible Continuity; and yet it is manifest, that an heap of Hairs dextrously twisted into small threads and woven into a close webb, makes a Continued body, though the Hairs do not penetrate each other, but are meerly contingent in their extremes. Thus mudd is likewise a Continued Body, though it be only a composition of Granules of Earth and Water reciprocally contingent; as appears by the separation of them, upon the easie evaporation of the watery particles by fire. Thus also, in a word, all Bodies, which are dissoluble by fire, or otherwise, have their parts only mutually contingent; all that the Dissolvent effects upon them, being only to divorce them from reciprocal Contact, and so destroy their apparent Continuity.

Art. 10. That no Body is perfectly Continued, beside an *Atome*.

This considered, if any man enquire, what Body is so perfectly Continued, as not to consist of only Contingent, and consequently of separable particles; it is evident, that the whole vast stock, or Magazine of Nature can afford him none such, an *Atome* only excepted: and therefore of an Atome alone are we to understand that ænigmatical sentence of *Democritus*, recorded by *Aristotle* (7. *Metaphys.* 13.) *Neque ex uno duo, neque ex duobus unum fieri posse*; because the *Insectility* of an Atome makes the emergency of two out of one, clearly impossible, and its *Solidity* interdicts the mutual penetration of two, necessary to their perfect Coalition into one. So that it is absolutely necessary, that all Atoms remain single and inconfused: and

and yet this hinders not, but a Body, which is not actually divided into parts, may be said to be Continued; insomuch as it so appears to the sense, which cannot discern the several Commissures of its particles.

Art. 11. *Aristotles* Definition of a *Continuum*, in what respect true, and what false.

Again, forasmuch as *Aristotle* defines a *Continuum* to be that, *whose Parts are conjoyned by some Common mean, or Term*; it is requisite we observe how far forth his definition is consistent with right reason. We allow it to be true *Physically* so far forth, as there are no two parts assignable, which are conjoyned by some third intermediate part, either *sensible* (as in a magnitude of three feet, the two extreme feet are copulated together by the third intermediate) or *Insensible* (as in the magnitude of two feet, which are joyned together by some interjacent particle, so small as to evade the detection of sense): But, if with Him we accept that Common Mean, or Terme, for a *Mathematical Point*, or individual (for He expresly affirms, that the parts of a Line are copulated by a Point; the parts of a Superfice, by a Line; the parts of a Body, by a Line, or Superfice) tis plain, that our Conceptions must be inconsistent with Physical verity; because such *Insectiles*, or Individuals are not real, but only Imaginary, as we have copiously asserted in our Discourse concerning the *Impossible Division of a Continuum into parts infinitely subdivisible.* Besides, who can conceive that to be a *Cament* or *Glew* to unite two parts into one Continued substance, which hath it self no parts designable either by sense or reason? Nor can any thing be rightly admitted to conjoyn two Bodies, unless it hath two sides, Extremes, or faces; one whereof may adhære to one of the two Bodies; the other to the other, so as to make a sensible Continuity.

Art. 12. *Figure* (Physically considered) nothing but the *superficies*, or terminant Extremes of a Body.

Concerning the Quality of a Body called FIGURE, that which is chiefly worthy our præsent adversion, is onely this; that if Figure be considered *Physically*, it is nothing but *the superficies, or terminant Extreames of a Body.* We say, *Physically*; because Geometricians distinguish Figures into *Superficial*, or *Plane*, and *Profound*, or *Solid*: but the Physiologist knows no other Figure properly, but the *Superficial*; because, in strict truth, the Profound or Solid one seems to Him, to be rather the Magnitude, or Corpulency of a thing circumscribed or terminated by its Figure, than the Figure it self abstractedly intended. Nay, if we insist upon the rigour of verity, the Figure of a Body is really nothing but the *Body it self*; at least, the meer *Manner* of its Extreme parts, according to which our sense deprehends it to be smooth or rough, elated or depressed. This may be most fully evinced by only one Example, *viz.* the figure made upon Wax by the impression of a Seal. For, that Figure really is nothing but the very substance of the Wax, in some parts made more Eminent, in others more depreſt, or profound, according to the Reverse of its Type ingraven in some hard substance; and that without Adjection, or Detraction of any Entity whatever. And what we affirm of the Figure made in Wax by Sigillation, is of equal truth (proportionately) if accommodated to any other Figure whatever: nor doth it imply a Difference, whether the Figure be *Natural*, such as in Animals, Vegetables, Minerals; or *Artificial*, such as in Ædifices, Statues, Characters, &c.

Sect. II.

Art. 1. The Continuity of this, to the first Section.

THe Causes of Magnitude and Figure in Concretions, being thus investigated; it follows, that we explore their Effects, i. e. the *Qualities* which seem so immediately cohærent to the Magnitude and Figure of Bodies, as that reason cannot consigne them to more likely and probable Principles, than the two First Proprieties of the Universal Matter, Atoms.

Art. 2. *Subtility* and *Hebetude*, how the Consequents of Magnitude.

The Consequents, therefore, of Magnitude, are SUBTILITY and its contrary, HEBETUDE. Not that the Emergency of a Great Body from Atoms the most Exile; or of a small body from great Atoms, is impossible; as we have formerly intimated: but, that a Body consisting of more Exile, or subtile Atoms, hath a greater subtility, or obtains a Faculty of penetrating the contexture of another body, by subingression into the pores, or inane spaces thereof; and a body consisting of grosser Atoms, must have more of Grossness or Hebetude, and so hath not the like Faculty of penetrating the Contextures of other bodies, by subingression into the inane spaces, or intervals betwixt their particles. This may be Exemplified in *Fire* and *Water*; *Wine and Oyle*; *Aqua Fortis and Milk*, &c.

Art. 3. A considerable Exception of the Chymists (*viz.* that some Bodies are dissolved in liquors of grosser particles, which yet conserve their Continuity in liquors of most subtile and corrosive particles) prevented.

We are not now to learn the truth of that Chymical Canon, *Cuique fermè rei solvendæ, vel extrahendæ eligendum esse idoneum menstruum, quod ejus naturæ respondeat*: experience having frequently ascertained us, that Aqua Regis, which soon dissolves the most compact of bodies, Gold, will not at all impair Resine, Pitch, Wax, and many other Unctuous and Resinous Concretions; which yeild almost at first touch to the separatory faculty of oyle: that Mercurial Waters expeditely insinuate into the substance of Gold, dissolve the Continuity of its stiffly cohærent particles, and convert it from a most solid into an oyly substance; not so much by Corrosion, as symbolisme or Affinity of nature: that Salt, Nitre, and Sulphur, which being added to Sand, Flints, and many Metals, promote the solution, in a reverberatory fire; have yet no accelerating, but a retarding energy upon Turpentine, Balsome, Myrrh, &c. in the extraction of their Oyls, or Spirits: that all Waters, or Spirits extracted from Saline and Metalline natures are most convenient Menstruaes for the solution of Metals & Minerals; not so much in respect of their Corrosion, as similitude of pores and particles: and consequently that every Concretion requires to its dissolution some peculiar dissolvent, that holds some respondency or analogy to its contexture. But, yet have we no reason, therefore to abandon our *Assumption*, that the dissolution of one body, by the subingression or insinuation of the particles of another, must arise from the greater subtility of particles in the Dissolvent; until it be commonstrated to us, that a Body, whose Particles are less exile, can penetrate another Body, whose Pores are more exile, the contrary whereto is demonstrated to us by the frequent Experiments of Chymistry.

And,

And, therefore, the Reason, Why *Oyle Olive* doth pervade some Bodies, which yet are impenetrable even by *spirit of Wine* (by *Raimundus Lullius*, and after him by *Libavius* and *Quercetan*, accounted the true Sulphur and Mercury of Hermetical Philosophers, extracted from a Vegetable, for the solution of Gold into a Potable substance, and the Confection of the Great Elixir; and as General a Dissolvent, as that admired (but hardly understood) Liquor Alkahest of *Paracelsus*, if not the same) can be no other but this: that in the substance of Oyle are some Particles much more subtile and penetrative, than any contained in the substance of Wine; though those subtile particles are thinly interspersed among a far greater number of Hamous, or Hooked particles, which retard their penetration. Thus also in that affrighting and Atheist-converting Meteor, *Lightning*, seem to be contained many particles much more exile and searching than those of our Culinary Fires: because it sometimes dissolves the hardest of Metals in a moment, which preserves its integrity for some hours in our fiercest reverberatory furnaces. Which *Lucretius* well expresseth in this Tetrastich;

Art. 4. Why *Oyle* dissociates the parts of some Bodies, which remain inviolate in *Spirit of Wine*: and why *Lightning* is more penetrative than *Fire*.

Dicere enim possis, cæleſtem Fulminis ignem
Subtilem magis, è parvis conſtare Figuris;
Atque ideo tranſire foramina, quæ nequit ignis
Noſter hic è lignis ortus tædaque creatus.

Secondly, the Qualities Consequent to Figure, are SMOOTHNESSE, and its contrary, ASPERITY. Not that, if we appeal to the judgement of the sense, the superfice of a Body may not be smooth, though it consist of angulous Atoms; or rough, though composed of plain and polite Atoms: for, all Atoms, as well as their Figures, are so Exile, as that many of them that are angular, may cohære into a mass, without any inequality in the superfice deprehensible by the sense; and on the contrary, many of those that are plane and polite, may be convened and concreted into such masses, as to make angles, edges, and other inequalities sufficiently sensible. But, that if we refer the matter partly to the judicature of Reason, partly to the evidence of our senses in General; we cannot but determine it to arise from the Figuration of Atoms alone. First, to the judicature of *Reason*; for, as the mind admits nothing to be perfectly continued, besides an Atom: so can it admit nothing to be exquisitely smooth, besides either the whole superfice of an Atom, if the same be orbicular, oval, or of the like Figure; or some parts of it, if the same be tetrahedical, hexahedrical, or of some such poligone figure. Because, look by what reason the mind doth conclude the superfice of no Concretion in nature to be perfectly continued: by the same reason doth it conclude the superfice of every thing, seemingly most equal and polite, to be variously interrupted with asperities, or eminent, and depreſt particles; and this it refers immediately and solely to many small masses of Atoms, in the Contexture coadunated, like as it referrs the interruptions in the superfice of a piece of Lawne, or Cambrique, which to the eye and touch appears most smooth and united, to the small masses of Filaments interwoven in the webb. And here the Experiment of a *Microscope* is opportune; for, when a man looks through it upon a sheet of the finest and smoothest Venice Paper, which seems to the naked eye, and most exquisite touch, to be equal and terse in all parts of it superfice; He shall discern it to be so full

Art. 5. *Smoothness* and *Asperity* in Concretions, the Consequents of *Figure* in their Material Principles.

of Eminences and Cavities, or ſmall Hills and Valleys, as the moſt prægnant and præpared Imagination cannot ſuppoſe any thing more unequal and impolite. Secondly, to the *Evidence of our ſenſes in General*; becauſe, the very Affection of Pleaſure or Pain, ariſing to the ſenſory from the contact of the ſenſible object, doth ſufficiently demonſtrate, that *ſmoothneſs* is a Quality reſulting either from ſuch Atoms, or ſuch ſmall maſſes of Atoms contexed, as are ſmooth and pleaſant to the ſenſe, by reaſon of their correſpondence to the pores and particles of the Organ: and contrariwiſe, that *Aſperity* is a Quality, reſulting either from ſuch ſingle Atoms, or ſuch moſt minute maſſes of Atoms concreted, as dilacerate, or exaſperate the ſenſe, by reaſon of their incongruity or Diſproportion to the Contexture of the Organ; as we have, even to redundancy, Exemplified in the Grateful and Ungrateful Objects of each ſenſe.

CHAP.

CHAP. XI.

OF THE Motive, Vertue, Habit, Gravity, and Levity OF CONCRETIONS.

SECT. I.

THe Third Propriety of the Universal Matter, Atoms, is *Mobility*, or *Gravity*: and from that fountain is it that all Concretions derive their *Virtue Motive*. For, though our deceptable *sense* inform us, that the minute Particles of Bodies are fixt in the act of their Coadunation, wedged up together, and as it were fast bound to the peace by reciprocal concatenation and revinction: yet, from the Dissolution of all Compound natures, in process of time, caused by the intestine Commotions of their Elementary Principles, without the hostility of any External Contraries, may our more judicious *Reason* well inferr, that Atoms are never totally deprived of that their essential Faculty, Mobility; but are unc essantly agitated thereby even in the centrals of Concretions, the most solid and compact; some tending one way, others another, in a perpetual attempt of Eruption, and when the Major part of them chance to affect one and the same way of emancipation, then is their united force determined to one part of the Concretion, and motion likewise determined to one region, respecting that Part. That same MOTIVE VIRTUE, therefore, wherewith every Compound Bodie is naturally endowed, must owe its origine to the innate and co-essential Mobility of its component particles; being really the same thing with their Gravity, or *Impetus*: which yet receives its determinate manner and degree from their mutual Combination. In respect whereof it necessarily comes to pass, that when Atoms, mutually adhæring unto, and detaining each other, cannot obey the impulse of

Art. I. The *Motive Virtue* of all Concretions, derived from the essential *Mobility* of Atoms.

of their tendency singly, they are not moved with that pernicity, as if each were at absolute liberty; but impeding and retarding each other in their progress, are carried with a slower motion, But that more or less slow, according to the rate or proportion of common Resistence: because always some of them are carryed to an opposite, others transversly, others obliquely to a different region.

Art. 2. Why the Motive Virtue of Concretions doth reside principally in their *spiritual* Parts.

And hence is it, that because Atoms are at most freedom of range in subtile and spiritual Concretions; every degree of Density and Compactness causing a proportionate degree of Tardity in their spontaneous motions: therefore is the Motive Faculty not more generally, than rightly conceived, to reside chiefly in the *spiritual*, or (as vulgar Philosophy) *Æthereal* Parts of al Concretions. And, whether the spirits of a thing are principally determined to move, thither do they not only themselves contend, with great impetuosity and speed; but also carry along with them the more sluggish; or less moveable parts of the Concretion; as is superlatively manifest in the Voluntary motions of Animals.

Art. 3. That the *Deviation* of Concretions from motion Direct; and their *Tardity* in motion: arise from the *Deflections* and *Repercussions* of Atoms composing them

We need not here insist upon the Redargution of that Blasphemous and Absurd (for the former Epithite always implies the later) dream of *Epicurus*, that Atoms were not only the First *Matter*, but also the First and sole *Efficient* of all things; and consequently that all Motions, and so all Actions in the Universe are Caused meerly by the inhærent Mobility of them: because we have expressly refuted the same in our Treatise against *Atheism*, (*Chap.* 2. *Sect.* 1. *artic. ultim.*). Especially, since it is more opportune for us here to advertise; that insomuch as the motion of all Atoms is supposed to be of itself Direct, and most rapid; therefore doth the Deviation, as well as the Tardity of Concretions seem to arise from the Deflection, Repercussion, or multiplied Repression of the Atoms composing them. For, the Occursation or meeting of two Atoms, may be in direct lines; so that among Atoms, either by single percussion, or repercussion overcoming the first begun motion, as the assembly or Convention will bear, there may be caused some motions Direct, though more or less slow: and their Occursations may be also according to Oblique angles, and so, by the same reason may ensue a motion, not only more or less slow, but also more or less Oblique. Moreover, if after one repercussion made to oblique angles, there chance to follow a second, a third repercussion to angles equally oblique; then must the motion be pursued in obliquity multangular, according to the multiplicity of Repercussions: and if the Angles be very frequent and indistant, the motion becomes, at least to appearance, to be of an uniform Curvity, and may therefore be termed a motion Circular, Elliptical, Helicoidal, or the like, according to the condition of its Deflection and Crookedness.

Art. 4. Why the motion of all Concretions necessarily præsupposeth something, that remains *unmoved*; or that, in respect of its slower motion, is equivalent to a thing Unmoved.

Moreover we are to observe, that every Body, whether Simple or Compound, i. e. Atom or Concretion, from which a Repercussion is made, must either quiesce, or not be moved the same way, as is the repercust, or not with so swift a motion; because, otherwise there can be no mutual *Antilypia*, or *Resistence*, nor the impingent body rebound from the repercutient. And this is the only reason, why (excepting only the motion essential to Atoms.) the motion of all Concretions doth ever suppose something that

that remains Unmoved, or that, in respect of its less motion, is tantamount to a thing Unmoved: because, otherwise there could be no reciprocal Resistence, and so all motion might both begin and repair it self.

Art. 5. What the *Active Faculty* of a thing, is.

Having thus premised these few fundamental Laws of Motion in General, opportunity commands us to descend to the consideration of the FACULTY of Motion: insomuch as it seems not to be any thing distinct from that Motive Force, inhærent in all Concretions, which we have now both described, and deduced from its immediate origine, the Mobility of Atoms; and that it is well known to all Book-men, to appertain to the second species of Qualities, according to the method of *Aristotle.* To which we may add these lessons also, that it comprehends the Third species of Qualities, and obtains the First, or Habit, as its proper appendix. Know we, therefore, that the Faculty or Power of Motion doth therefore seem to be one and the same thing with the coessential Mobility, now described; because every thing in Nature is judged to have just so much of Efficacy, or Activity, as it hath of Capacity to move either it self, or any other thing.

Art. 6. That in Nature every Faculty is *Active*: none Passive.

And hence is it, that in Nature there is no Faculty (properly) but what is *Active*; because, though the motions of things be really the same with their Actions: yet must all motion have its beginning only from the Movent, or Agent. Nor can it avail to the contrary, that all Philosophers have allowed a Passive Faculty to be inhærent in all Concretions; since, in the strict dialect of truth, that Passiveness is no other than a certain Impotency of Resistence, or the Privation of an Active Power, in defect whereof the subject is compelled to obey the Energy of another. If you suppose an obscure Contradiction in this our Assertion, and accordingly Object; that therefore there must be a Faculty of Resistence, in some proportion, and that that Resistence is Passive: we are provided of a satisfactory salvo, which is, that though the Active Virtue, which is in the Resistent, doth sometimes scarce discover it self, yet is it manifest, that there are very many things, which make resistence only by motion, which no man can deny to be an Active Faculty; as when we rowe against wind and tide, or strive with a Bowe in the drawing of it, for all these evidently oppose our force by contrary motion. And, as for other things, which seem to quiesce, and yet make some resistence; such we may conceive to make that resistence by a kinde of motion, which Physicians denominate a Tonick motion; like that of the Eye of an Animal, when by the Contraction of all its muscles at once it is held in one fixt position. Thus not only the whole Globe of the Earth, but all its parts are held unmoved, and first by mutual cohærence, and resist motions as they are parts of the whole: and thus also may all Concretions be conceived to be made Immote, not that the Principles of which they consist, are not in perpetual inquietude and motion; but, because their particles reciprocally wedge and implicate each other, and while some impede and oppose the motions of others, they all conspire to the Consistence of the whole. However the more Learned and Judicious shall further dispute this paradoxical Argument; yet dare we determine the Common Notion of a Faculty to be this, that there is inherent in every thing a Principle of Moving itself, or Acting, if not *Primary* (which the schools terme the *Forme*) yet *Secondary* at least, or profluent from the Forme,

Forme, being as it were the immediate *Instrument* thereof.

Art. 7. A *Peripatetick Contradiction*, assuming the *Matter* of all Bodies to be devoid of all Activity; and yet desuming some Faculties *â tota substantia.*

And here we cannot conceal our wonder, that the *Peripatetick* hath not for so many ages together discovered himself to be intangled in a manifest Contradiction; while on one part He affirms, that there are certain Faculties flowing *â tota substantia*, from the whole substance of a thing, as if they were derived from the matter of Concretions: and on the other, concludes, as indisputable, that the Matter is absolutely devoid of all Activity, as if it were not certain, that the Faculties frequently perish, when yet not the whole and intire substance of the thing perisheth; but only the spiritual, or more tenuious parts thereof.

Art. 8. That the *Faculties* of Animals (the Ratiocination of man only excepted) are Identical with their *spirits.*

Now, what more prægnant Argument than this can the most circumspect desire, in order to their Conviction, that the *Faculties* of an Animal (we exclude the Rational Faculty of man, from the sphere of our assertion) are *Identical* with the *Spirits* of it, i.e. the most subtile, most free, and most moveable or active part of its materials? For, though the spirits are by vulgar Philosophers conceived to be only the Primary Organ, or immediate Instrument, which the Faculty residing in one part, occasionally transmits into another: yet, to those Worthies, who have with impartial and profound scrutiny searched into the mystery, hath it appeared more consentaneous, that the spirits are of the same nature with the Faculty, and not only movent, but Instrument; nor can it stand with right reason to admit more than this, that as water in the streams is all one specifically with that in the fountain, so is the Faculty, keeping its court or chief residence in one part of the body, as it were the Fountain, or Original, from whence to all other parts, inservient to the same function, the diffusion of spirits is made, in certain exile rivolets, or (what more neerly attains the abstrusity) Rayes, like those emitted from the Sun, or other fountain of light. And, what we here say, of the Faculties of Animals, holds equal truth, also concerning those of Inanimate Concretions; allowing a difference of proportion.

Art. 9. The Reasons of the Coexistence of *Various Faculties* in one and the same Concretion.

But here ariseth a considerble *Difficulty*, that at first view seems to threaten our Paradox with total ruine; and this it is: if the Faculties of Concretions be not distinct in essence from their spirits, or most agile particles; *how then can there be so many various Faculties coexistent in one and the same concretion*, as are dayly observed; for in an Apple, for example, there is one Faculty of affecting the sight, another of affecting the taste, a third affecting the smell. Concerning this, therefore, we give you this solution, that the coexistence of varions Faculties in one Concretion, doth depend upon (1) *the variety of multiforme particles, of which the whole Concretion doth consist*, (2) *the variety of particles and special contexture of its divers parts*, (3) *the variety of External Faculties, to which it happens that they are applied.* To keep to our former Example, in an Apple, tis manifest, there are some particles, in which consisteth its faculty of affecting the smell, others in which consisteth its faculty of affecting the Tast; for, the Experiments of Chymistry demonstrate, that these different particles may be so sequestred each from other, as that the tast may be conserved, when the smell is lost, and

and the ſmell conſerved, when the taſte is aboliſhed. And in an Animal it is no leſs evident, that the organ of one ſenſe hath one peculiar kind of contexture, the organ of another ſenſe another: and finally, that when we ſhall referr the Faculties of Odour and Sapour, which are in an Apple, to the Faculties of ſmelling and taſting in Animals; they become ſubject to a further diſcrimination. Since the ſame particles, which move the ſmelling, ſhall create a ſweet and grateful odour, in reſpect of one Animal, and an offenſive or ſtinking, in reſpect of another: and in like manner, thoſe particles, which affect the Taſte, ſhall yeild a moſt grateful and deſireable Sapour, to one Animal, and as odious and deteſtable a one to another. Ought we, therefore, to account that Faculty of an Odour, which is in an Apple, either *Single*, or *Multiplex?* If we would ſpeak ſtrictly, it is *Single Abſolutely*: *Reſpectively, Multiplex*. And thus, indeed, may we affirm, that in the General, or abſolutely, an Apple is Odorous and Sapid: but Comparatively and in Special, that it is fragrant, or fœtid; ſweet or bitter.

Art. 10. *Habit* defined.

As for that Appendix of a Faculty, which not only Philoſophers, but the People alſo name a HABIT; Experience daily teacheth, that there are ſome Faculties, (in Animals eſpecially) which by only frequency of acting grow more prompt and fit to act: and upon conſequence, that that Hability or promptneſs for action, is nothing but a Facility of doing, or repeating that action, which the ſame Faculty, by the ſame inſtruments, hath frequently done before.

Art. 11. That the *Reaſon* of all *Habits* in Animals, conſiſteth principally in the *conformity* and *flexibility* of the *Organs*, which the reſpective Faculty makes uſe of, for the performance of its proper Actions.

And, as to the *Reaſon* of this Facility; though it ariſe in ſome meaſure from the Power or Faculty it ſelf, or the Spirits, as being accuſtomed to one certain motion: yet doth it chiefly depend upon the Diſpoſition of the *Organs*, or inſtruments which the Faculty makes uſe of in the performance of its proper action. For, becauſe the Organ is alwayes a Diſſimilar or Compound Body, conſiſting of ſome parts that are craſs and rigid; we are to conceive it to be at firſt ſomewhat ſtubborn, and not eaſily flexible to ſuch various motions, as the Faculty requires to its ſeveral operations: and therefore, as when we would have a Wand to be every way eaſily flexible, we are gently and frequently to bend it, that ſo the tenour of its fibres running longwiſe through it, may be here and there and every where made more lax, without any ſenſible divulſion; ſo if we deſire to have our hands expedite for the performance of all thoſe difficult motions that are neceſſary to the playing of a Leſſon on the Lute, we muſt by degrees maſter that rigidity or clumſineſs in the Nerves, Tendons, Muſcles and joints of our fingers, yea in the very skin and all other parts of our hands. Thus alſo Infants, while they ſtammer, and ſtrive again and again to pronounce a word clearly and diſtinctly, do no more than by degrees maſter the ſtiffneſs and ſluggiſhneſs of their tongues and other vocal organs, and ſo make them more flexible and voluble: and when by aſſuefaction they have made them eaſily flexible to all the motions required to the formation of that idiome, then at length come they to ſpeak it plainly and perfectly. The ſame is alſo true, concerning the Brain, and thoſe Organical parts therein, that are inſervient to the act of Imagination, and by the imagination to the act of Diſcourſe. For, though the Mind, when divorced from the the body, can operate moſt readily, and knows no difficulty or impediment in the act of Intellection; as being Immaterial, and ſo wanting no organs

for the exercise of its reasoning Faculty: yet nevertheless, while it is adliged to the body and its material instruments, doth it remain subject to some impediment in the execution of its functions; and because that impediment consisteth only in the less aptitude or inconformity of its proper organs, therefore the way to remove that impediment, is only by Assuefaction of it to study and ratiocination. And from this Assuefaction may the Mind be affirmed to acquire a certain Habit or Promptitude to perform its proper Actions; insomuch as by reason of that Habit, it operates more freely and expeditely: but, yet, in stricter Logick, that Habit ariseth chiefly to its Organs; as may be inferred only from hence, that the Organs are capable of increment and decrement, and to increase and decrease, is competent only to a thing that consisteth of parts; such as is the Organ, not the Mind.

Art. 12. *Habits*, acquirable by *Bruits*: and common not only to *Vegetables*, but also to some *Minerals*.

Nor is the acquisition of a Habit by assuefaction proper only to Man, but in common also to *all Living Creatures*, such especially as are used to the hand and government of Man, as Horses, Doggs, Hawks, and all prating and singing Birds. And where we affirmed, that some Faculties are capable of advancement to perfection by Habit; we intended, that there are other Faculties which are *incapable* thereof, as chiefly the *Natural Faculties* in Animals, and such as are not subject to the regiment of the Will: though still we acknowledge that some of these there are, which upon change of temperament in their respective Organs, may acquire such a certain Habit, as may oppose the original inclination; and of this sort the principal is the Nutrient Faculty, which may be accustomed even to Poison. Lastly, when we, said *Chiefly in Animals*; we were unwilling totally to exclude *Plants*; because they also seem (at least Analogically) to acquire a kind of Habit: as is evident from their constant retaining of any posture or incurvation, which the hand of the Gardiner hath imposed upon them, while they were tender and flexible; as also that they may by degrees be accustomed to forein soils, and (what is more admirable) if in their transplantation those parts of them, which at first respected the South or East, be converted to the North or West, they seldome thrive, never attain their due procerity. Nay, if the Experiments of some Physitians be true, *Minerals* also may be admitted to attain a Habit by assuefaction; For *Baptista van Helmont*, (*in lib. de Magnetica Vulnerum curatione, & lib. de Pestis tumulo*) reports that He hath found a Saphire become so much the more efficacious an Attractive of the pestilential Venome from the Vitals, by how much the more frequently it hath been circumduced about Carbuncles or Plague Sores; as if Custome multiplied its Amuletary Virtue and taught it a more speedy way of conquest.

SECT. II.

Art. 1. *Gravity*, as to its *Essence*, or *Formal Reason*, very obscure.

AMong all Qualities of Concretions, that deduce themselves from the Mobility of Atoms, the most eminent is GRAVITY, or the motion of perpendicular Descent from Weight. Which, though most obvious to the observation of Sense, hath much of obscurity in its Nature; leading the Reason of Man into various and perplext Conceptions concerning its Causes: nor hath the judgment of any been yet so fortunate as to light upon a Demonstrative Theory concerning it, or fix upon such a determination as doth not lye open to the objection of some considerable Difficulty. So that it may well seem Ambition great enough for us, onely with due uprightness to examine the Verisimility of each opinion, touching the Formal Reason, or Essence of Gravity: that so we may direct younger Curiosities, in which they may, for the præsent, most safely acquiesce.

Art. 2. The opinion of *Epicurus*, good as to the Cause of *Comparative*: insufficient as to the Cause of *Absolute* Gravity.

Epicurus, indeed, well desumes the Gravity of all Concretions, immediately from the Gravity of Simple Bodies, or Atoms: insomuch as all things are found to have so much more of Weight, as they have of Atoms, or Matter, that composeth them; and *è contra*. Which reason the exact *Joh. Bapt. Balianus*, a Nobleman and Senatour of *Genoa*, seriously perpending; sets it down as a firm ground, *Gravitatem se habere ut Agens, Materiam vero, seu Materiale corpus, ut Passum; & proinde gravia moveri juxta proportionem gravitatis ad materiam: & ubi sine impedimento naturalitèr perpendiculari motu ferantur, moveri æqualitèr; quia ubi plus est Gravitatis, plus ibi paritèr sit Materiæ, seu Materialis quantitatis*; (*de motu Gravium Solidorum & Liquidorum, lib.* 1. *cap.* 1.). But, this being too General, and concerning rather the Cause of Comparative, than Absolute Gravity; leaves our Curiosity to a stricter search.

Art. 3. *Aristotles* opinion of Gravity, recited.

The Grand Dictator of the Schools, *Aristotle*, taking it for granted [*Unumquodque sensilium ita in suum locum ferri, ut ad speciem*] that every corporeal Nature is by native tendency carried to its proper place, as to its particular Species; confidently inferrs this doctrine: that Gravity and Levity are Qualities essentially inexistent in Concretions (4. *de Cælo, cap.* 2.) and passionately reprehending *Democritus* and *Leucippus*, for affirming that there is no such thing in Nature, as Absolute Gravity, or Absolute Levity; concludes, that in Nature is something absolutely Heavy, which is Earth, and something Absolutely Light, which is Fire; (*de Cælo, lib.* 4. *cap.* 4.) But, neither of these Positions are more than Petitionary; and so not worthy our assent: as the Context of our subsequent Discourse doth sufficiently convince.

Art. 4. *Copernicus* theory of Gravity, insatisfactory; and wherein.

The Third opinion worthy our memory, is that of *Copernicus*, who considering, that all Heavy Bodies, either projected Upwards by external violence, or dropt down from some eminent place, are observed to fall perpendicularly down upon the same part of the Earth, from which they were elevated, or at which they are aimed, and so that the Earth might be thence argued not to have any such Diurnal Vertigo, as His Systeme ascribes unto it, insomuch as then it could not but withdraw it self from Bodies falling down in direct lines, and receive them at their fall not in the same place, but some other more Westernly: we say, considering this, *Copernicus* determined Gravity to be, not any Internal Principle of tendency toward the middle, or Centre of the Universe; but an innate propension in the parts of the Earth, separated from it, to reduce themselves in direct lines, or the nearest way, to their Whole, that so they may be conserved together with it, and dispose themselves into the most convenient, i. e. a sphærical figure, about the centre thereof. His words are these; *Equidem existimo, Gravitatem non aliud esse, quàm Appetentiam quandam naturalem, partibus inditam à Divina Providentia Opificis Universorum; ut in unitatem integritatemque suam sese conferant, in formam Globi coeuntes: quam Affectionem credibile est etiam Soli & Lunæ, cæterisque Errantibus fulgoribus inesse; ut ejus efficacia in ea, quâ se repræsentant, rotunditate permaneant.* (*lib.* 1. *cap.* 9.). So that according to this *Copernican Assumption*, if any part of the Sun, Moon, or other Cœlestial Orb were divelled from them; it would, by the impulse of this natural tendency, soon return again in direct lines to its proper Orb, not to the Centre of the Universe. Which as *Kepler* (*in Epitom. Astronom. pag.* 95.) well advertiseth, is but a Point, i. e. Nothing, and destitute of all Appetibility; and therefore ought not to be accounted the Term of tendency to all Heavy Bodies, but rather the Terrestrial Globe together with its proper Centre, yet not as a Centre, but as the *Middle* of its Whole, to which its Parts are carried by Cognation.

But, this opinion hath as weak a claim to our Assent, as either of the former; as well because it cannot consist with the Encrease of Velocity in all Bodies descending perpendicularly, by how much nearer they approach the Earth, unless it can be demonstrated, that this encrease of Velocity in each degree of descent, ariseth only from the Encrease of Appetency of Union with the whole (which neither *Copernicus* himself, nor any other for Him, hath yet dared to assent): as in consideration of many other Defects, and some Absurdities, which, that wonder of the Mathematicks, *Ricciolus*, hath demonstratively convicted it of (*in Almegisti novi parte posteriori, lib.* 9. *sect.* 4. *cap.* 16. *de Systemate terræ motæ.*). Who, had He but as solidly determined all the Difficulties concerning the immediate Cause of this Affection in Bodies, called Gravity; as He hath refuted the Copernican Thesis of an Innate Appetency in the parts of the Earth to reunite themselves to the Whole: doubtless He had much encreased the obligations and gratitude of his Readers. But, making it his principal design to propugn the Physiology and Astronomy of the Ancients, especially such Tenents as are admitted by the Schools, and allowed of by the Doctors of *Rome*, as most concordant to the litteral

litteral ſenſe of Sacred Writ: He waved that Province, ſeeming to adhære to the common Doctrine of the *Stagirite*, formerly recited, and only occaſionally to defend it.

Art.5. The Determination of *Kepler*, *Gaſſendus*; &c. that Gravity is Cauſed meerly by the *Attraction* of the *Earth*: eſpouſed by the *Author*.

Laſtly, there are Others (among whom *Kepler* and *Gaſſendus* deſerve the richeſt Minervals) who, neither admitting with *Ariſtotle*, that Gravity is any Quality eſſentially inhærent in Concretions; nor, with *Copernicus*, that it is an Appetency of Union, implanted originally in the parts of the Earth, by vertue whereof they carry themſelves towards the Middle of the Terreſtrial Globe: define it to be an *Impreſt Motion, Cauſed immediately by a certain Magnetick Attraction of the Earth.*

And this opinion ſeems to carry the greateſt weight of Reaſon; as may ſoon be manifeſt to any competent and equitable judgment, that ſhall exactly perpend the ſolid Arguments alledged by its Aſſertors: which for greater decorum, we ſhall now twiſt together into one continued thread, that ſo our Reader may wind them into one bottome, and then put them together into the ballance.

Art. 6. The *External Principle* of the perpendicular Deſcent of a ſtone, projected up in the Aer; muſt be either *Depellent*, or *Attrahent*.

Inſomuch as frequent and moſt accurate obſervation demonſtrates, that the Motion of a Body downward doth encreaſe in the ſame proportion of Velocity, that the motion of the ſame Body, violently projected upward, doth decreaſe; therefore is it reaſonable, nay neceſſary for us to conceive, that there are *Two diſtinct External Principles*, which mutually contend about the ſame ſubject, and execute their contrary forces upon the ſame Moveable. Now, of theſe two Antagoniſtical Forces, the one is *Evident*; the other *obſcure*, and the argument of our inſtant Diſquiſition. *Manifeſt* it is, when a ſtone is thrown upward from the ſurface of the Earth into the Aer, that the External Principle of its motion *Upward*, is the Hand of Him, who projected it: But ſomewhat *obſcure*, what is the External Principle of its motion *Downward*, when it again returns to the Earth. Nevertheleſs, this obſcurity doth not imply a Nullity; i.e. it is high temerity to conclude that there is no External Cauſe of the ſtones Deſcent, becauſe that External Cauſe is not equally manifeſt with that of its Aſcent: unleſs any dare to affirm, that becauſe He can perceive, when Iron is attracted to a Loadſtone, no Externall Cauſe of that Attraction, therefore there can be none at all. Many, indeed, are the wayes, by which an External Cauſe may move a Body: and yet they all fall under the comprehenſion of only two Cardinal wayes, and thoſe are *Impulſion*, and *Attraction*.

Art. 7. That the *Reſiſtence* of the *Superior Aer* is the only Cauſe which gradually refracteth, and in fine wholly overcometh the *Impreſt Force*, whereby a ſtone projected, is elevated upward.

This præconſidered, it followes, that we caſt about to finde ſome Cauſe, or Impellent, or Attrahent (or rather two Cauſes, one Impellent, the other Attrahent, operating together) to which we may impute the perpendicular motion of Bodies Deſcending. The *Impellent* Cauſe (if any ſuch there be) of the perpendicular motion of a ſtone Deſcending, can be no other but the *Aer*, from above incumbent upon, and preſſing it downward: becauſe of any other External Cauſe of that effect, no argument can be given. For, ſhould you ſuppoſe a ſphere of Fire, or ſome other

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or ſome other Æthereal Subſtance, to be immediately above the convex Extreme of the ſphere of Aer; which cloſely and with ſome kind of preſſure invironing the Aer, might compel all its parts to flow together toward the Terraqueous Globe: yet could that ſuper-aereal ſphere, bounded and urged by the circumvolutions of the Cœleſtial Orbs, do no more, than cauſe the Aer, being it ſelf preſt downward, to bear down upon the ſtone, and ſo depreſs it; and ſo the Aer muſt ſtill be at leaſt the *Proxime* Cauſe impelling the ſtone downward. Moreover, that the Aer alone may be the Impellent Cauſe of the ſtones perpendicular Decidence from on high, even *Ariſtotle* Himſelf ſeems to concede; inſomuch as He is poſitive in his judgment, that when a Heavy body projected upward is abandoned by its Motor, it is afterward moved only by the Aer, which being moved by the Projicient, moves the next conterminous Aer, by which again the next neighbouring Aer is likewiſe moved, and ſo ſucceſſively forward untill the force of the Impreſt motion gradually decaying, the whole communicated motion ceaſeth, and a quiet ſucceeds. But, becauſe *Ariſtotle* could not tell, what Cauſe that is, which in every degree of the ſtones aſcent oppoſing, at length wholly overcomes the impreſt force; unleſs it ſhould be the occurrent ſuperiour Aer, which continually reſiſteth the inferior aer, whereby the projected ſtone is promoted in its aſcent: may not we ſafely enough conclude, that the Aer from above incumbent upon the projected ſtone, may by the ſame force depreſs it Downward, wherewith it firſt reſiſted the motion of it Upward? Doubtleſs, what force ſoever the Hand of a man, who projects a ſtone upward into the Aer, doth impreſs upon it, and the contiguous Aer; yet ſtill is it the ſuperiour Aer, that both continually reſiſteth the tendency of the ſtone upward, and at its ſeveral degrees of aſcent refracteth the force thereupon impreſt by the hand of the Projicient, untill having totally overmaſtered the ſame, it ſo encreaſeth its conquering Depellent force, as that in the laſt degree of the ſtones Deſcendent motion, the Depreſſive force of the Aer is become as great, as was the Elevating force of the Hand, in the beginning of its Aſcendent motion. Suppoſe we, that a Diver ſhould from the bottome of the Sea throw a ſtone directly upward, with the ſame force, as from the ſurface of the Earth up into the Aer; and then demand, Why the ſtone doth not aſcend to the ſame height in the Water, as in the Aer. Is it not, think you, becauſe the water doth more reſiſt, and refract the Impreſt force, and ſo ſooner overcome it, and then begins to impreſs its own concontrary Depreſſing Force thereupon, never diſcontinuing that impreſſion, till it hath reduced the ſtone to the bottom of the Sea, from whence it was projected? The Difference, therefore, betwixt the Reſiſtence of the Impreſt force, by the Water, and that of the Aer, conſiſteth only in Degrees, or more and leſs. And, though the Renitency of the Aer may be thought very inconſiderable in compariſon of that great Violence impreſt upon a Cannon Bullet, ſhot upward into the Aer: yet be pleaſed to conſider, that it holds ſome inveſtigable proportion, with the Renitency of the Water. Which proportion that we may underſtand, compare we not only the very ſmall Aſcent of a ſtone, thrown upward from the bottome

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of the Sea, to the large ascent of the same stone, with equal force, from the Earth, thrown up into the Aer; but also the almost insensible progress of a Bullet shot from a Cannon transversly through Water, with that vast progress it is commonly observed to make through the Aer: and we shall soon be convinced, that as the Great Resistence of the Water is the Cause, why the Stone, or Bullet makes so small a progress therein; so is the small Resistence of the Aer the Cause why they both pervade so great a space therein. And thus is it Demonstrable, that the *Resistence of the superior Aer, is the External Agent, which constantly resisteth, by degrees refracteth, and at length wholly overcomes the impreſt Force, whereby Heavy Bodies are violently elevated up into the Aer.*

Art.8. That the Aer, distracted by a stone violently ascending, hath as well a *Depulsive*, as a *Resistent* Faculty; arising immediately from its *Elaterical*, or *Restorative* motion.

The Difficulty remaining, therefore, doth only concern the *Impellent Cause of their Fall Down again*; or, whether the Aer, besides the force of Resistence, hath also any *Depulsive Faculty*, which being impreſt upon a stone, bullet, or other ponderous body, at the top, or highest point of its mountee, serveth to turn the same Downward, and afterward to continue its perpendicular descent, till it arrive at and quiesce on the Earth. Which, indeed, seems well worthy our Doubt, because it is observable, that Walls, Pavements, and the like solid and immote Bodies, though they strongly resist the motion of bodies impinged against them; doe not yet impress any Contrary motion thereupon: the Rebound of a Ball or Bullet from a Wall, being the effect meerly of the same force impreſt upon it by the Racket, or Gun-powder fired, which first moved it; as is evident even from hence, that the Resilition of them to greater or less distance, is according to the more or less of the Force impreſt upon them. Which those Gunners well understand, who experiment the strength of their Powder, by the greatness of the bullets rebound from a Wall.

And to solve this Difficulty, we must *distinguish* betwixt Bodies, that are devoid of Motion, and which being distracted, have no faculty of Restitution, whereby to recollect their dissociated particles, and so repair themselves; of which sort are Walls, Pavements, &c: and such bodies that are actually in motion, and which by reason of a natural Elater, or Spring of Restitution, easily and speedily redintegrate themselves, and restore their severed parts to the same contexture and tenour, which they held before their violent distraction; to which classis the Aer doth principally belong. Now, concerning the *First* sort, what we object of the non-impression of any Contrary motion upon Bodies impinged against them, is most certainly true: but not concerning the *Latter*. For, the Arm of a Tree, being inflected, doth not only resist the inflecting force, but with such a spring return to its natural site, as serveth to impel any body of competent weight, that shall oppose its recurse, to great distance; as in the discharge of an Arrow from a Bow. Thus also the Aer, though otherwise unmoved, may be so distracted by a Body violently pervading it; as that the parts thereof, urged by their own native Confluxibility (the Cause of all Elaterical or Restorative Motion) must soon return to their natural tenour and site, and not without a certain violence, and so replenish the place

place formerly poſſeſt, but now deſerted by the body, that diſtracted them. That there is ſo powerful a *Reſtorative* faculty in the Aer, as we here aſſume; innumerable are the Experiments, thoſe eſpecially by Philoſophers uſually alledged againſt a Vacuum Coacervate, which atteſt. However, that you may the leſs doubt of its having ſome, and a conſiderable force of propelling bodies notwithſtanding it be *Fluid* in ſo high a degree: be pleaſed only to reflect your thoughts upon the great force of Winds; which tear up the deepeſt and firmeſt rooted Cedars from the ground, demoliſh mighty Caſtles, overſet the proudeſt Carracts, and rowle the whole Ocean up and down from ſhoar to ſhoar. Conſider the incredible violence, wherewith a Bullet is diſcharged from a Wind-Gun, through a firm plank of two or three inches thickneſs. Conſider that no effect is more admirable, than that a very ſmall quantity of Flame ſhould, with ſuch prodigious impetuoſity, drive a Bullet, ſo denſe and ponderous, from a Cannon, through the Gates of a City, and at very great diſtance: and yet the Flame of the Gunpowder is not leſs, but more Fluid than Aer. Who, without the certificate of Experience, could believe, that meerly by the force of ſo little Flame (a ſubſtance the moſt Fluid of any, that we know) not onely ſo weighty a Bullet ſhould be driven with ſuch pernicity forward through the aer to the diſtance of many furlongs; but alſo that ſo vaſt a weight, as a Cannon and its Carriage bear, ſhould at the ſame time be thereby driven backwards, or made to recoyle? What therefore will you ſay, if this could not come to paſs, without the concurrence of the Aer? For, it ſeems to be effected, when the Flame, at the inſtant of its Creation, ſeeking to poſſeſs a more ample room, or ſpace, doth convert its impetus, or violence as well upon the breech, or hinder part of the Canon, as upon the bullet lying before it in the bore or Cartridge; which diſcharged through the concave, is cloſely preſt upon by the purſuing flame: ſo that the flame immediately periſhing, and leaving a void ſpace, the Aer from the front or adverſe part inſtantly ruſheth into the bore, and that with ſuch impetuous pernicity, as it forceth the Cannon to give back, and yeilds a Fragor, or Report, as loud as Thunder; nay, by the Commotion of the vicine Aer, ſhakes even the largeſt ſtructures, and ſhatters Glaſs-windows, ſituate in the ſphere of its violence. And all meerly from the Elaterical Motion of the Aer, reſtoring its diſtracted parts to their natural tenour, or Laxity: ſo that you may be ſatisfied of its Capacity not only to reſiſt the Aſcent of a ſtone thrown upward; but alſo of *Depelling it downward, by an impreſt Motion.*

Art. 9. That nevertheleſs, when a ſtone, projected on high in the Aer, is at the higheſt point of its mountee; no Cauſe can *Begin* its Downward Motion, but the *Attractive Virtue* of the *Earth.*

Notwithſtanding our conqueſt of the main body of this Difficulty, about the Reſtorative Motion of the Aer, we are yet to encounter a formidable Reſerve, which conſiſts of theſe *Scruples.* When a ſtone is thrown upward, doth not the Aer in each degree of its aſcent, ſuffer a *Diſtraction* of its parts; and ſo is compelled by a *Perioſis*, or circular motion, to ſucceed into the place left below by the ſtone? Doth it not therefore impreſs rather an Elevatory, than a Depulſive Force thereupon, and ſo promote the

the force impreſt upon it by the hand of Him, who projected it? And muſt it not thence follow, that the firſt impreſt motion is ſo far from being decreaſed by the ſuppoſed Renitency of the ſuperior Aer, that it is rather increaſed and promoted by the Circulation thereof: and upon conſequence, that the ſtone is carried upward twice as ſwiftly, as it falls downward, ſince it is impelled upward by two forces, but falls down again only by a ſingle force? True it is, that while a ſtone is falling down, the diſtracted aer beneath ſeems to circulate into the place above deſerted thereby: but, in caſe a ſtone be held up on high in the Aer by a mans hand, or other ſupport, and that ſupport be withdrawn ſo gently, as to cauſe no conſiderable commotion in the Aer; in this caſe there ſeems to be no reaſon, why the Aer ſhould flow from above down upon it in the firſt moment of its delapſe. Beſides, when a ſtone projected upward, hath attained to the higheſt point of its aſcent, at which there ſeems to be a ſhort pauſe, or reſpite from motion, cauſed by the æquilibration of the two Contrary Forces, the Movent and Reſiſteut: why doth not the ſtone abſolutely *quieſce* in that place, there being in the Aer no Cauſe, which ſhould rather Depel it downward, then elevate it upward?

Theſe conſiderations, we ingenuouſly confeſs, are potent, and put us to the exigent of exploring ſome other External Principle, beſide the motion of Reſtitution in the Aer; ſuch as may *Begin* the Downward motion of the ſtone, when gently dropt off from ſome convenient ſupporter, or when it is at the zenith or higheſt point of its aſcent, and and at the term of its Æquilibration overcome the Reſiſtence of the ſubjacent Aer, that ſo it may not only yeeld to the ſtone in the firſt moment of its Deſcent; but by ſucceſſive Circulations afterward promote and gradually accelerate its motion once begun. Depellent Cauſe there can be none; and ſo there muſt be ſome *Attrahent*, to begin the ſtones præcipitation: and that can be no other, but a *Certain peculiar Virtue of the whole Terreſtrial Globe, whereby it doth not onely retain all its Parts, while they are contiguous or united to it, but alſo retract them to it ſelf, when by any violence they have been avulſed and ſeparated.* And this Virtue may therefore be properly enough called *Magnetique.*

Art. 10. *Argument*, that the Terraqueous Globe is endowed with a certain *Attractive Faculty*, in order to the Detention and Retraction of all its Parts.

In Nature, nothing is whole and entire, in which there is not radically implanted a certain ſelf-Conſervatory Power, whereby it may both contain its ſeveral parts in cohærence to it ſelf, and in ſome meaſure reſiſt the ſeparation or diſtraction of them; as all Philoſophers, upon the conviction of infinite Experiences, decree: and if ſo, it were a very partial Abſurdity to bereave the Terraqueous Globe, being a Body whole and entire, of the like conſervatory Faculty. And hence comes it, that if any Parts of the Earth be violently avelled from it; by this Conſervatory, (which muſt be *Attractive*) Virtue, it in ſome meaſure reſiſteth their avulſion, and after the ceſſation of the Avelling violence, retracteth them again; and this by inſenſible Emanations, or ſubtile threads, deradiated continually from its whole body, and hookt or faſtned to them: as a man retracts a Bird flown from his hand, by a line or thread tyed to its feet.

Art. 11. What are the *Parts* of the Terrestrial Globe.

By the *Parts of the Terrestrial Globe* we intend not only the parts of Earth and Water (the liquid part of the Earth, and as Blood in an Animal) nor only all stones, Metalls, Minerals, Plants, Animals, and whatever Bodies derive their principles from them, such as Rain, Dew, Snow, Hail, and all Meteors, Vapours, and Exhalations; nor only the Aer, wherewith the globe of Earth is circumvested, as a Quince or Malacotone is periwiggd about with a lanuginous or Hoary substance, (because, if we abstract from the surface of the Earth all vapours, expirations, fumes, and emanations of subtle bodies from water and other substances, which ascend, descend, and everywhere float up and down in the Atmosphere; nothing can remain about the same, but an Empty space,) but also Fire it self, which hath its original likewise from terrestrial matter, as wood, oyl, fat, sulphur, and other unctuous and combustible substance. Because all these are Bodies, which as Parts of it self the Earth containeth and holds together; not permitting any of them to be avelled from its orbe, but by some force that exceeds its retentive power: and when that avellent force ceaseth, it suddainly retracts them again to it self. And, insomuch as two bodies cannot coexist in one and the same place at once; therefore comes it to pass, that many bodies being at once retracted toward the Earth, the more terrene are brought neerer to the surface thereof, extruding and so succeeding into the rooms of the less terrene: whence the neerer adduced and Extruding Bodies are accounted *Heavy*, and the Extruded and farther removed, are accounted *Light*.

Art. 12. A Second *Argument* that the Earth is *Magnetical.*

Secondly, that the Earth is naturally endowed with a certain Magnetical Virtue, by which perpetually diffused in round, it containeth its parts in cohærence, and reduceth those, which are separated from it self; after the same manner, as a Loadstone holds its own parts together, and attracts Iron (which is also a Magnetique Production, as *Gilbert* (*de magnet. lib.* 1. *cap.* 16.) from the observation of Miners, and other solid reasons, hath confirmed) to it self, and retracts it after divulsion or separation: we say, all this may be argued from hence, that the whole Globe of the Earth seems to be nothing but one *Grand Magnet.*

(1) Because a Loadstone, tornated into a sphere, is (more than Analogically only) a Little Earth: being therefore nicknamed by *Gilbert* (*de magnet. lib.* 1. *cap.* 3.) Μικρόγη, *Terella*; insomuch as the one, so also hath the other its Poles, its Axis, Æquator, Meridian, Parals.

(2) Excepting only some parts, which have suffered an alteration and diminution, if not a total amission of Virtue, in the Exteriors of the Earth; all parts thereof discover some magnetick impregnation: some more vigorous and manifest, as the Loadstone, and Iron; others more languid and obscure, as White Clay, Bricks, &c.

Whereupon *Gilbert* erects his conjectural judgement, that the whole Globe Terrestrial is composed of two General parts, the shell, and Kernel: the *Shell* not extending it self many hundred fathoms deep (which is very small comparatively to the vastness of its Diametre, amounting to 6872 miles, Italian measure) and all the rest, or Kernel, being one

one continued Loadſtone ſubſtantially. (3) The Loadſtone always converteth thoſe parts of it ſelf toward the Poles, which reſpected them in its mineral bed, or while it remaind united to the Earth. All which are no contemptible Arguments of our Theſis, that the whole Earth is endowed with a magnetique Faculty, in order to the Conſervation of its Integrity.

Art. 13. A Parallelijme betwixt the Attraction of Iron by a Loadſtone, and the Attraction of Terrene bodies by the Earth.

Whether the Entrals of our Common Mother, and Nurſe, the Earth, be, as *Gilbert* would perſuade us, one Great Loadſtone *ſubſtantially*; is not more impoſſible to prove, than impertinent to our præſent ſcope: it being ſufficient to the veriſimility of our aſſigned Cauſe of the perpendicular motion of Terrene Bodies, to conceive the Globe of the Earth to be a Loadſtone only *Analogically*, i. e. that as the Loadſtone doth perpetually emit certain inviſible ſtreams of exile particles, or Rays of ſubtle bodies, whereby to allect magnetical bodies to an union with it ſelf; ſo likewiſe doth the Earth unceſſantly emit certain inviſible ſtreams, or Rays of ſubtile bodies, wherewith to attract all its diſtracted and divorced Parts back again to an Union with it ſelf, and there cloſely to detain them. And juſtifiable it is for us to affirm, that from the Terraqueous Orbe there is a continual Efflux, not only of Vapours, Exhalations, and ſuch ſmall bodies, of which all our Meteors are compoſed; nor only of ſuch, as the general maſs of Aer doth conſiſt of: but alſo of other particles far more exile and inſenſible, nor leſs ſubtile than thoſe, which deradiated from the Loadſtone, in a moment permeate the moſt ſolid Marble, without the leaſt diminution of their Virtue. Becauſe, as the Attractive Virtue of the Loadſtone is ſufficiently demonſtrated by the Effect of it, the actual Attraction of Iron unto it: ſo is it lawful for us to conclude the Earth to be endowed with an Attractive Virtue alſo, meerly from the ſenſible Effect of that Vertue, the actual Attraction of ſtones, and all other bodies to it ſelf; eſpecially ſince no other Conception of the Nature of that Affection, which the world calls Gravity, can be brought to a cleer conſiſtence with that notable Apparence, the gradual Encreaſe of Velocity in each degree of a bodies perpendicular fall.

Art. 14. That as the ſphere of the Loadſtones Allective Virtue is *limited*; ſo is that of the Earths magnetiſm.

Beſides, the *Analogy* may be farther deduced from hence; that as the Virtue of the Loadſtone is diffuſed in round, or ſpherically, and upon conſequence, its Effluvia, or Rays are ſo much the more rare, by how much the farther they are tranſmitted from their ſource or original; and ſo being leſs united, become leſs vigorous in their attraction, and at large diſtance, i. e. ſuch as exceeds the ſphere of their Energy, are languid and of no force at all: ſo doth the Terreſtrial Globe diffuſe its Attractive Virtue in round, and upon conſequence, its Effluvia, or Rays become ſo much the more rare or diſperſed, by how much farther they are tranſmitted from their fountain; and ſo being leſs united, cannot attract a ſtone or other terrene body at exceſſive diſtance, ſuch as the *Supralunary* and *Ultramundane* ſpaces. Which that we may aſſert with more perſpicuity, let us ſuppoſe a ſtone to be placed in thoſe Imaginary ſpaces which are the outſide of the World, and in which God, had He ſo pleaſed,

might have created more worlds; and then examine, whether it be more reasonable, that that stone should rather move toward this our Earth, than remain absolutely immote in that part of the Ultramandan spaces wherein we suppose it posited. If you conceive, that it would tend toward the Earth; imagine not only the Earth, but also the whole machine of the world to be Annihilated, and that all those vast spaces, which the Universe now possesseth, were as absolutely Inane, as they were before the Creation: and then at least, because there could be no Centre, and all spaces must be alike indifferent, you will admit, that the stone would remain fixt in the same place, as having no Affectation, or Tendency to this part of those spaces, which the Earth now possesseth. Imagine the World to be then again restored, and the Earth to be resituate in the place as before its adnihilation; and then can you conceive that the stone would spontaneously tend toward it? If you suppose the *Affirmative*; you will be reduced to inextricable difficulties, not to grant the Earth to affect the stone, and upon consequence, to transmit to it some certain Virtue, consisting in the substantial Emanations, not any simple and immaterial Quality, whereby to give it notice of its being restored to its pristine situation and condition. For, how otherwise can you suppose the stone should take cognizance of, and be moved toward the Earth. Now, this being so, what can follow, but that stones, and all other Bodies accounted Heavy, must tend toward the Earth, only because they are *Attracted* to it, by rays or streams of Corporeal Emanations from it to them transmitted? Go to then, let us farther imagine, that some certain space in the Atmosphere, were, by Power supernatural, made so Empty, as that nothing could arrive thereat either from the Earth, or any other Orbe: can you then conceive, that a stone placed in that Inanity, would have any Tendency toward the Earth, or Affectation to be united to its Centre? Doubtless, no more, than if it were posited in the Extramundan spaces: because, having nothing of Communication therewith, or any other part of the Universe, the case would be all one with the stone, as if there were no Earth, no World, no Centre. Wherefore, since we observe a stone from the greatest heighth, to which any natural force can elevate the same, to tend in a direct or perpendicular line to the Earth; what can be more rational than for us to conceive, that the Cause of that Tendency in the stone is onely this, that it hath some communication with the Earth; and that not by any naked or Immaterial Quality, but some certain Corporeal, though most subtile Emanations from the Earth? Especially, since the Aer incumbent upon the stone, is not sufficient to Begin its motion of Descent.

Art. 15. An *Objection* of the Disproportion between the great Bulk of a large stone and the Exility of the supposed magnetique Rays of the Earth: *Solved* by three weighty Reasons.

If you shall yet withhold your Assent from this Opinion, which we have thus long endeavoured to defend; we conjecture the Remora to be chiefly this: that it seems improbable, so great a Bulk, as that of a very large stone, and that with such pernicity, should be attracted by such slender means, as our supposed magnetick Emanations: and therefore think it our duty to satisfie you concerning this Doubt. We Answer (1) That a very great quantity of Iron (proportionately) is easily and nimbly rusht into the arms of a Loadstone meerly by Rays of most subtle particles, such as can be discovered no way, but by their Effect. (2) That stones, and other massy Concretions have no such great ineptitude, or Resistence to motion,

motion, as is commonly præſumed. For, if a ſtone of an hundred pound weight be ſuſpended in the Aer, by a ſmall wier, or chord: how ſmall a force is required to the moving of it hither? Why therefore ſhould a greater force be required to the Attraction of it downward. (3) When you lift up a ſtone or other body from the Earth, you cannot but obſerve that it makes ſome Reſiſtence to your Hand, more or leſs according to the bulk thereof; which Reſiſtence ariſeth from hence, that thoſe many magnetique lines, deradiated to, and faſtned upon it, by their ſeveral Deflexions and Decuſſations, hold it as it were faſt chained down to the Earth, ſo that unleſs a greater force intervene, ſuch as may maſter the Earth Retentive power, and break off the magnetique lines, it could never be avelled and amoved from the Earth. And hence is it, that by how much the greater force is impreſt upon a ſtone, at its projection upward; by ſo many more degrees of exceſs doth that impreſt force tranſcend the force of the Retentive Magnetique lines, and conſequently to ſo much a greater Altitude is the ſtone mounted up in the Aer: and *è contra.* Which is alſo the Reaſon, why the Impreſt Force, being moſt vigorous in the firſt degree of the ſtones aſcent, doth carry it the moſt vehemently in the beginning; becauſe it is not then Refracted: but afterward the ſtone moves ſlower and ſlower, becauſe in every degree of aſcention, it looſeth a degree of the Impreſt Force, until at length the ſame be ſo diminiſhed, as to come to an Æquipondium with the Contrary force of the magnetique Rays of the Earth detracting it Downward.

Art. 16. The Reaſon of the *Æquivelocity* of Bodies, of different weights, in their perpendicular Deſcent: with ſundry unqueſtionable *Authorities* to confirm the *Hoti* thereof.

Laſtly, from hence is it, that the perpendicular Delapſe of moſt Bodies, though of far different weights, is obſerved to be Æquivelox: contrary to that Axiome of *Ariſtotle* (2. *de Cælo*, *text* 46) *quo majus fuerit corpus, eo velocius fertur*, and (*text* 77.) *parvum terræ particulum, ſi elevatu dimittatur, ferri deorſum, quo major fuerit, velocius moveri*; upon which the Ariſtoteleans have grounded this erroneous Rule, *Velocitates gravium deſcendentium habere inter ſe eandem proportionem, quàm gravitates ipſorum*, that the Velocities of Heavy bodies falling downward have the ſame proportion one to another as their Gravities have.

And the Reaſon of this Æquivelocity of Unequal weights, ſeems to be this; that of two Bullets, the one of only an ounce, the other of an hundred pounds weight, dropt from the battlements of an high tower, at the ſame inſtant, though the Greater Bullet be attracted by more magnetique lines deradiate from the Earth, yet hath it more particles to be attracted, than the Leſſer: ſo that there being a certain Commenſuration betwixt the Force Attractive, and the quantity of Matter Attracted; on either part the Force muſt be ſuch, as ſufficeth to the performance of the motion of either in the ſame ſpace of time; and conſequently, both the Bullets muſt deſcend with equal Velocity, and arrive at the ſurface of the Earth in one and the ſame moment. All which that Lynceus, *Galilæo* well underſtood, when (in the Perſon of *Salviatus*) deſiring to calculate the time, in which a Bullet might be falling from the concave of the Moon to our Earth; and *Sagredus* had ſaid thus to Him, *Sumamus igitur globum determinati ponderis*,

ponderis, & quidem illum ipsum, cujus descentionis ex Luna tempus metiri volumus: He positively answered Him, *Id verò nihil interest, &c.* It makes no difference whatever the weight of the Bullet be, because if four Bullets, the one of one pound, the second of ten, the third of an hundred, the fourth of a thousand pounds weight, be let fall together from the altitude of an hundred cubits, they shall all perform their perpendicular motions in the same proportion of time, and attain the Earth in the same moment. (*Dialog. 2. de systemat. cosmico, pagina Latina* 164.) The same also exactly consists with the frequent Experiments of *Joh. Baptista Balianus*, who (*in lib.* 1. *de motu Gravium, pag.* 4.) saith thus; *Inter alia dum anno millesimo sexcentesimo undecimo, per paucos menses, ex patriæ legis præscripto, Præfectum Arcis savonæ agerem; ex militaribus observationibus quæ occurrebant, illud maximè deprehendi, ferreos, & lapideos tormentorum bellicorum globulos, & sic corpora gravia, seu ejusdem, seu diversæ, speciei, in inæquali satis Mole, & gravitate, per idem spatium æquali tempore & motu, naturaliter descendere; idque ita uniformiter, ut repititis experimentis mihi plane constiterit, duos ex prædictis globis, vel ferreos ambos, vel alterum lapideum, alterum plumbeum, eodem planè momento temporis dimissos sibi, per spatium quinquaginta pedum, etiam-si unus esset libræ unius tantum, alter quinquaginta, in indivisibili temporis momento, subjectum solum ferire, ut unus tantum amborum ictus sensu perciperetur.*

To this Certificate we might subscribe the concurrent testimonies of *Nich. Cabæus* (*in meteor lib.* 1. *text.* 11. *quæst.* 5. *&* 6.) of *Arriaga* (*Disputatione* 4. *de Generatione, Sectione* 5, *subsectione* 3) of *Gassendus* (*de motu impresso à motore translato, Epist.* 1.): but we think it better, to refer our Reader to the touchstone of his own easie and cheap *Experiment*, as the most certain way of conviction.

Art. 17. That the *whole* Terrestrial Globe is devoyd of Gravity: and that in the universe is no *Highest*, nor *Lowest* place.

Moreover, insomuch as the Terrestrial Globe, considered in its whole, hath no need of any Direct or Perpendicular motion, whereby to tend to its proper place in the Universe; because it never recedeth from its proper place therein: but the Parts of it only have need of a Direct or Perpendicular motion, whereby they may be reduced to their proper place, the whole Earth, from which they are frequently separated: therefore must it have been unnecessary for the Creator to have endowed the whole Terrestrial Globe with Gravity or any Force, whereby it might be directly carryed to a place, out of which it should be constitute; and sufficient only to endowe it in the whole with such an Attractive Virtue, whereby it might retain its parts in adhærence to it self, and retract them to an union, when violently distracted from it. For, that Motion Direct or Perpendicular, which the Vulgar ascribes to Gravity, is *Motus Unitivus*, a Motion Unitive or Congregative of all the Parts of the Earth; as may be argued from hence, that it is the same in the Antipodes, as in our Hemisphere, and from all points of the Earths circumference conspires to one and the same common Centre. But, though this motion is Congregative of all Parts of the Earth related or brought back to an union with

with the great body or Globe thereof; yet is it not Congregative of the whole Globe to any thing elſe, as if the Globe of the Earth were to be united to the Moon, or any other Orbe in the World. Nor can it be affirmed, that Gravity, or this Virtue to motion Direct, is conceded to the Terraqueous Orbe, to the end it ſhould, at the Creation, carry it ſelf to that place, which is Loweſt in the Univerſe; or being there poſited, conſtantly retain it ſelf therein: ſince in the Univerſe is neither Higheſt, nor Loweſt place; but only Reſpectively to the ſite of an Animal, and chiefly of Man, whoſe Head is accounted the Higheſt, and Feet the Loweſt part; in the ſame manner as there is no Right, nor Left ſide in Nature, but comparatively to the ſite of the parts in mans body, and in reference to the Heavens. For, thoſe Lateralities are not determined by any general and certain ſtandard in Nature: but variouſly aſſigned according to our Imagination. The Hebrews, Chaldeans, and Perſians, confronting the Sun at his ariſing in the Eaſt; place the Right ſide of the world in the South: as likewiſe did all the Roman Southſayers, when they took their Auguries. The Philoſopher takes that to be the Eaſt, from whence the Heavens begin their Circumgyration: and ſo aſſigns alſo the right hand to the South. The Aſtronomer, regarding chiefly the South and Meridian Sun, accounts that the Dextrous part of Heaven, which reſpecteth his right hand, and thats the Weſt. And Poets, differing from all the reſt, turn their faces to the Weſt, and ſo aſſign the term of Right to the North: for otherwiſe *Ovid* muſt be guilty of a groſs miſtake in that verſe, *Utque duæ dextrâ Zonæ, totidemque ſiniſtrâ.* Hence is it, that as the Eaſt cannot be the Right ſide of the World, unleſs to Him, who faceth the North: ſo is the Vertical point of the world not to be accounted the Higheſt part of the Univerſe, but onely as it reſpecteth the Head of a man ſtanding on any part of the Earth; becauſe, if the ſame man travail to the Antipodes, that which was before the Higheſt, will then be the Loweſt part of the World. This conſidered, we muſt præfer that ſolid opinion of *Plato*, that in the World there is an Extreme, and a Middle Place, but no Higheſt and Loweſt; to that meerly petitionary one of *Ariſtotle*, that all Bodies tend toward the Centre of the Earth, as to the Loweſt place in the Univerſe.

Art. 18. That the Centre of the Univerſe is not the Loweſt part thereof: nor the Centre of the Earth, the Centre of the World.

How, ſaith the offended *Peripatetick*, the *meerly Petitionary opinion of Ariſtotle?* Why, do not all men admit that to be the Loweſt part of the World, which is the Middle or Centre thereof? And is not that the Centre of the Earth?

And our *Reply* is, that, indeed, we can admit *Neither.* (1) Becauſe, ſhould we allow the World to have a Middle, or Centre; yet is there no neceſſity, that therefore we ſhould concede the Centre to be the Loweſt place in the World; no more than that the Navil, or Central part of a man ſhould therefore be the Loweſt part. For, to ſpeak like men, who have not enſlaved their reaſon to præjudice; what is oppoſed to the *Middle*, is not ſuprem, but *Extreme:* and Higheſt and Loweſt are oppoſite points in the ſame Extreme. So likewiſe in the Terreſtrial Globe, whoſe middle part we account not the Loweſt, but the contrary point in the ſphear: ſince, otherwiſe we muſt grant the Earth to have a double *Infinity*, one in regard of its Centre, the other in reſpect of the extreme points

points of its Diametre, acco rding to which the Antipodes are Loweſt to us, and we Loweſt to them.

(2) Who dares prætend to demonſtrate, that there is an Extreme in the Univerſe; or if there be, to determine where and what it is: and upon conſequence, whether the Univerſe hath any Centre, and where that Centre is: Tis more than *Galilæo* durſt, as appears by that his modeſt confeſſion; *Neſcimus quidem ubi ſit Univerſi centrum, neque an ſit: quodque, ſi maxime detur, aliud nihil eſt, niſi punctum imaginarium, adeoque nihilum, omni facultate deſtitutum.* (*ſyſtemat Coſmici dialog.* 1 *pag.* 22) Beſides, we ſee it to be, and upon very good grounds, diſputed amongſt the moſt Curious and Learned wits of the world, whether the Fixt ſtars are moved about the Earth, or the Earth by a Diurnal motion upon its own axis? Whether the Fixt ſtars be all in one and the ſame concave ſuperfice: or rather (as the Planets, which notwithſtanding the deluded ſight, are demonſtrated not to be in one, but different ſpheres) ſome farther from, ſome neerer to the Earth, diſperſed in the immenſe ſpace? For, from hence, that the Diſtance betwixt them and us is ſo vaſt, that our ſight not diſcerning the large ſpaces intercepted betwixt them in their ſeveral orbes; they all appeare at the ſame diſtance, all in the ſame circumference, woſe Centre muſt be there, where the Eye turning it ſelf about, doth behold them: ſo that in whatſoever part of the immenſe ſpace of the World, whether in the Moon, Sun, or any other Orb, you ſhall imagine your ſelf to be placed; ſtill you muſt, according to the evidence of your ſight, judge the World to be ſpherical, and that you ſtand in the very centre of that Circumference, in which you conceive all the Fixt ſtars to be conſtitute.

Truly, it is worthy the admiration of a wiſe man, to obſerve, that the very Planets are admitted by the *Ariſtoteleans* to have certain motions Excentrique, i.e. to be moved in ſuch Gyres, as have not their Centres in the Earth, but in places immenſly diſtant from it: and yet that the ſame Perſons ſhould ſo openly Contradict themſelves, as to account that the Centre of the Earth is that common Centre of the world, about which all the Cœleſtial orbes ar circumduced. Theſe Difficulties perpended, we cannot infallibly determine, whether or no Earthy Bodies, when deſcending in direct lines to the Earth, are carried toward the Centre of the World: and though they ſhould be carried toward the Centre of the World, yet doth that ſeem to be only by Accident, as it is alſo by Accident, that they are carried toward the Centre of the Earth; in which as being a meer imaginary Point, they can neither be received nor attain quiet. For, *per ſe*, they are carried toward the Earth, as to their Whole, or Principle; and having once attained thereto, ſo acquieſe on the ſurface of it, as they no more ſeek to paſs on from thence to its Centre, than an Infant received into his Nurſes armes or lap, cares to ſink farther into her Entrals: and meerly *per Accidens* is it, that they are directed toward the Centre of the Earth; becauſe tending in the neereſt cut, or ſhorteſt line to the place of their quiet, they muſt be directed toward the Centre, ſince if we ſuppoſe that direct line to be continued, it muſt paſs through the Centre of the Earth. And thus have we left no ſtone unſubverted, in all *Ariſtotles* Theory of Gravity, which is, *that Weight is a Quality eſſentially inhærent in all terrene Concritions, whereby they ſpontaneouſly tend toward the Centre of the Terreſtrial Globe, as to the Common Centre, or Loweſt place in the Vniverſe.* The whole Remainder of our præſent Aſſumption, therefore, concerns our farther Confirmation of that opinion touching the Eſſence of Gravity, which we have eſpouſed; which is, that *it is the meer Effect of the Magnetique Attraction of the Earth.*

Let

Let us therefore once more resume our Argument *à Simili*, considering the Analogy betwixt the Attraction of Iron by a Loadstone, and that of Terrene Concretions by the Earth; not only as to the Manner of their respective Attractions, but cheifly as to the parity of Reasons in our judgements upon their sensible Effects. When a man holds a plate of Iron of 6 or 7 ounces weight, in his hand, with a vigorous Loadstone placed at convenient distance, underneath his hand; and finds the weight of the Iron to be encreased from ounces to pounds: If *Aristotle* on one side should tell him, that that great weight is a Quality essentially inhærent in the Iron, and *Kepler* or *Gilbert*, on the other, affirm to him, that that weight is a quality meerly *Adventitious*, or impreſt upon it by the Attractive influence of the Loadstone subjacent; 'tis easie to determine, to which of those so contrary judgements he would incline his assent. If so, well may we conceive the Gravity of a stone, or other terrene body, to belong not so much to the Body it self, as to the Attraction of that Grand Magnet, the Terraqueous Globe lying underneath it. For, supposing that a Loadstone were, unknown to you, placed underneath your hand, when you lifted up a peice of Iron from the earth; though it might be pardonable for you to conclude, that the great weight, which you would observe therein, was a Quality essentially inhærent in the Iron, when yet in truth it was only External and Attractitious; because you were ignorant of the Loadstone subjacent; yet, if after you were informed that the Loadstone was placed underneath your hand, you should persever in the same opinion, the greatest Candor imaginable could not but condemn you of inexcusable pertinacity in an Error. Thus also your ignorance of the Earths being one Great Loadstone may excuse your adhærence to the erroneous position of *Aristotle*, concerning the formal Reason of Gravity; but, when you shall be convinced, that the Terrestrial Globe is naturally endowed with a certain Attractive or Magnetique Virtue, in order to the retention of all its parts in cohærence to it self, and retraction of them when by violence distructed from it, and that gravity is nothing but the effect of that virtue; you can have no Plea left for the palliation of your obstinacy, in case you recant not your former persuasion.

Art. 19. A *Fourth Argument*, that Gravity is only *Attraction*.

Nor ought it to impede your Conviction, that a far greater Gravity, or stronger Attractive Force is impreſt upon a piece of Iron by a Loadstone, than by the earth; insomuch as a Loadstone suspended, at convenient distance, in the aer, doth easily elevate a proportionate mass of Iron from the earth; because this gradual Disparity proceeds only from hence, that the Attractive Vertue is much more Collected or United in the Loadstone, and so is so much more intense and vigorous (according to its Dimensions) than in the Earth, in which it is more diffused; nor doth it discover how great it is in the single or divided parts, but in the Whole of the Earth. Thus, if you lay but one Grain of salt upon your tongue, it shall affect the same with more saltness, than a Gallon of Sea-water: not that there is less of salt in that great quantity of Sea Water, but that the salt is therein more diffused.

Art. 20. Why a greater Gravity, or stronger Attractive force is impreſt upon a piece of Iron by a Loadstone, than by the Earth.

But to lay aside the Loadstone and its Correlative, Iron, and come to our taste and *Incomparative Argument*; since the Velocity of the motion of a stone falling downward, is gradually augmented, and by the accession

Art. 21. A *Fifth Argument*, almost Apodictical; that Gravity is the Effect of the Earths Attraction.

of new degrees of Gravity, grows greater and greater in each degree of its Descent; and that Augmentation, or Accession of Gravity, and so of Velocity, seems not so reasonably adscriptive to any other cause, as to this, that it is the Attraction of the Earth encreasing in each degree of the stones Appropinquation to the Earth, by reason of the greater Density or Union of its Magnetique Rayes: What can be more Rational, than that the *First degree of Gravity*, belonging to a stone not yet moved, should arise to it from the same Attraction of the Earth? When, doubtless, it is one and the same Gravity that causeth both those Effects; the same *in Specie*, though not *in Gradu*: And no Quality can be better intended, or augmented, than by an Accession of more Degrees of force from the same Quality,

Sect. III.

Art. 1. *Levity*, nothing but *less Gravity*.

LAstly, as concerning LEVITY, which is vulgarly reputed the Contrary to Gravity, and by *Aristotle* defined to be a Quality inhærent in some Bodies, whereby they spontaneously tend upward; we understand it to be nothing but a *less Gravity*: and so that Gravity and Levity are Qualities of Concretions, not Positive, or Absolute, but meerly *Comparative*, or *Respective*. For, the same Body may be sayd to be Heavy, in respect to another that is Lighter; and Light, in respect to another that is Heavier. For Example, let us compare a Stone, Water, Oyle, and Fire (which we have formerly annumerated to Terrene Concretions) one to another; to the end that our Assertion may be both illustrated and confirmed at once. Water, we see, being poured into a vessel, immediately descends to the bottom thereof, and if permitted to settle, doth soon acquiesce: but, upon the dropping of a Stone into the same vessel, as the Stone descends, the Water ascends proportionately to give it room at the bottom. And Oyle, infused into a vessel alone, doth likewise instantly descend, and remains quiet at the bottom thereof: but, if Water be poured thereupon, the oyle soon ascends, and floats on the surface of the Water. If the Vessel be repleat only with Aer, the Aer quiesceth therein: but when you pour oyle into it, the Aer instantly ascends, and resignes to the oyle. Lastly, thus Fire would be immediately incumbent upon the surface of the Earth, and there acquiesce; but that the Aer, being circumstant about the superfice of the Terrestrial Globe, and the more weighty body of the two, doth extrude it thence by depressure, and so impell it upwards, to make room for it self beneath. And thus are all these Bodies Heavy and Light, *Comparatively* or *Respectively*. The Heaviest of them all is the Stone, as being the most strongly attracted by the Earth: or, is the least Light among them all, as being the least abduced from the Earth. And, Water, which is Light, in comparison of the Stone, is yet Heavy in comparison of Oyle: and

And Oyle, though Light in comparison of Water, is yet Heavy in comparison of the Aer. And Aer, though Light comparatively to Oyle, is yet Heavy in respect of Fire; which is the Lightest of them all, because it is the most elevated from the Earth: Or is the least Heavy among them all, because it is the least attracted by the Earth.

Art. 2. *Aristotle's* Sphere of Fire, extinguisht.

This considered, we cannot but smile at their Credulity, who can admit *Aristotles* dream of a peculiar *Sphere of Fire*; and thereupon contend, that Fire spontaneously ascends in quest of its sphere: When it is manifest, that Fire doth not mount up upon the wings of any native Tendency, or of that Imaginary Faculty, call'd Levity; but is driven upward by the impulsion of the Aer. Who is there dares affirm, that oyl, when pour'd forth of a vessel by some expert Diver, in the bottome of the Sea, doth ascend to the top of the water, in quest of a Sphere of Oyle? or that Water, elevated to the brim of a vessel upon the injection of sand into the same vessel, doth ascend spontaneously, and in pursuit of a Sphere of Water? Or that Aer, descending into a mine, doth spontaneously descend in quest of an Aereal Sphere? Or, that Fire it self, when it stoops down to catch hold of some uncteous and easily inflammable substance, as is often noted; doth still obey its essential Levity, in order to its reunition to its proper Sphere? And yet for all this, the world is full of those (so epidemick is the contagion of Præjudice) who dare affirm that ridiculous and grosly absurd Figment of the Ascension of Fire to an Igneous Sphere constitute we know not where belowe the Moon.

Art. 3. That Fire doth not Ascend spontaneously, but *Violently*; *i.e.* is impell'd upward by the Aer.

But we are yet to prove, that *Fire is impelled upward by the Aer.* Consider therefore, that Fire will not burn in a chymny, if all the doors, windows and chinks of the room be so closely shut, as that no supply of fresh Aer can be admitted into it: and the Reason is plainly this; that unless there be a source of fresh Aer to succeed into the place of that, which impels the Fire upward in the chimny, there can be no Continuation of the impuls or elevation of the Fire, and so the Fire must be extinguished; but when a liberty of ingression is left to the External Aer, then is the Internal Aer closely pursued by a fresh supply, and so the motion continued. Consider also that Fire always burns the clearer and sooner, if the fewel be laid hollow in a grate of Iron, or upon andyrons; than if it be imposed flatly upon the bare hearth: because, in the former case, the ambient Aer doth more easily and fluently insinuate it self underneath the Fire, and as it impells the flame upward, fan and blow the coals, like a pair of bellows. And this gave the Chymist the hint for the invention of his *Wind-Furnace*, which needs no other bellows but that constant stream of Aer, which flows in beneath the fewel, and ventilates the coals most strongly. And then Conclude, with *Copernicus (lib. 1. cap. 8.) Ignem nihil aliud esse, quàm huncie terrenum seu famam ardentem; cujus proprium est, extendere quæ invaserit: motum autem Extensivum esse à centro ad circumferentiam; sed terrestrem illum habitum,*

litum, ſeu fumum rapi in ſublime, & extrudi ſuum extra locum, ideoque ſtatim langueſcere tanquam confeſſâ cauſâ violentiæ, quæ terreſtri materiæ illata fuit: quapropter Levitatem non dari, aut non eſſe Connaturalem hiſce corporibus. Conclude alſo, with Us; that in the Earth indeed, there are Direct Motions Upward and Downward: but thoſe Motions are proper only to the *Parts* (as Gravity and Levity are likewiſe proper only to the Parts) not to the Whole, or Globe of the Earth.

CHAP.

CHAP. XII.

HEAT and COLD.

SECT. I.

THe Genealogy of those sensible Qualities of Concretions which arise from *either* of the three Essential Proprieties of Atoms, in its *Single* capacity, thus far extending it self; here begins that other of those, which result from any *Two*, or *All* of the same Proprieties, in their several *Combinations*, or *Associations*.

Art. 1. The Connection of this to the immediately precedent Chapter.

Of this order, the *First* are *Heat*, *Cold*, *Humidity*, *Siccity*; which though the Schools, building on the fundamentals of their Dictator, *Aristotle*, derive immediately and solely from the 4 First Qualities of the vulgar *Elements*, Fire, Aer, Water, Earth; yet, because those reputed Elements are but several Compositions of the Universal matter, and so must desume their respective Qualities from the consociated Proprieties of the same; and because the original of no one of those Qualities can be so intelligibly made out from any other Principles: therefore doth our reason oblige us, to deduce them only from the *Magnitude*, *Figure*, and *Motion* of *Atoms*.

Art. 2. Why the Author deduceth the 4 *First Qualities*, not from the 4 vulgar Elements; but from the 3 *Proprieties* of *Atoms*.

Concerning the First of this Quaternary, HEAT; we well know, that it is commonly conceived and defined by that relation, it bears to the sense of touching in Animals; or, as it is the Efficient of that passion, or Acute Pain, as *Plato* (in *Timæo*) calls it, which Fire, or immoderate Heat impresseth upon the skin, or other organ of touching; yet, forasmuch as this Effect, which it causeth in the sensient part of an Animal, is only special and Relative; therefore ought we to understand its Nature, from some *General* and *Absolute* Effect, upon which that Special and Relative one depends, and that is the *Penetration*, *Discussion* and *Dissolution* of Concretions.

Art. 3. The Nature of Heat is to be conceived from its *General* Effect; *viz.* the *Penetration*, *Discussion*, and *Dissolution* of Bodies concrete.

To

Art. 4. Heat defined as no Immaterial, but a *Substantial* Quality.

To come therefore to the Determination of its Essence, by the explanation of its Original; by *Heat*, as from our præcedent Disquisition of the Origine of Qualities in General may be præsumed, we do not understand any Aristoletean, *i.e.* naked or Immaterial Quality, altogether abstract from matter: but *certain Particles of matter, or Atoms, which being essentially endowed with such a determinate Magnitude, such a certain Figure, and such a particular Motion, are comparated to insinuate themselves into Concrete Bodies, to penetrate them, dissociate their parts, and dissolve their Contexture*; or, to produce all thus mutations in them, which are commonly adscribed to Heat, or Fire. Not that we gainsay, but Heat may be considered *Abstractly*, or as it is a certain peculiar *Manner*, without which a substance cannot calefie; in which sense *Anaximenes* (*apud Plutarch. de Frigore primigen.*) may be allowed to have spoken tollerably, when he said, *Neither Heat, nor Cold is substantial*, but affirm only, that it is not any thing abstracted from, and independent upon matter (as most have incircumspectly apprehended) or ought else, in Reality, but *Atoms themselves*, the substantial Principles as of all Concretions; so of all their Faculties or Qualities, and to which, as all Motion, so all Action ought to be imputed.

Art. 5. Why such Atoms, as are comparated to produce Heat, are to be Named the *Atoms of Heat*: and such Concretions, as harbour them, are to be called *Hot*, either *Actually*, or *Potentially*.

And albeit these Atoms, from which we derive this noble and most eminent Quality, Heat, be not Hot essentially; yet do they deserve the name of the *Atoms of Heat*, or *Calorifick Atoms*, insomuch as they have a capacity or power to Create Heat, *i.e.* cause that Effect, which consisteth in Subingression, Discussion, Exsolution. Likewise, those Bodies which contain such Atoms, and may emit them from themselves; ought also to be accounted Hot, insomuch as that by the emission of their Calorifick Atoms they are empowered to produce Heat in other bodies: and when they do Actually emit them, *i.e.* give their Calorifick Atoms liberty to pursue their own native Motions, after exsilition; then may they be said to be *Actually Hot*, or Formally Hot, as the Schools phrase it; but, while they contain them within themselves, and hinder their exsilition, they are Hot only *Potentially*. To the *First* of these Differences, we are to refer Fire: To the *Scond*, not only all those things, which Physicians call Calefactive Medicaments, such as Wine, Euphorlium, Peper, &c. but also all such as are capable of ignition, combustion, incalescence and the immission of Heat into other bodies objected, such as Wood, Resine, Wax, Oyle, &c. For, all such may be conceived to contain igneous or Calorifick Atoms, which during their revinction or imprisonment in Concretions, cannot pursue their motion, and so not produce Heat; but immediately upon the obtaining of their liberty, or emption, they manifest their nature in the production of heat.

Art. 6. The 3 necessary *Proprieties* of the Atoms of Heat.

Now, if we enquire What kind of Atoms these Calorifick ones are, and upon what their power of producing Heat depends; *Democritus*, *Epicurus*, and all the tribe of *Atomists* unanimously tell us, that they are *Exile in Magnitude*, *Spherical in Figure*, *most Swift in Motion*. And this upon very good reason. For, (1.) That they must be most *Exile in bulk*, is inferrible even from hence, that no Concretion can be so compact and solid, in which they will not find some pores or small inlets, whereat to insinuate themselvss into the Centrals of it, and penetrate thorow its substance; though perhaps not in so great a number, as is required, to the total dissolution

tion of its Contexture, as in the Adamant, which as Naturalists affirm, no Fire can demolish or dissolve. (2.) That they ought to be *Spherical in Figure*, is probable, yea necessary from hence; that of all others they are most Agile, and evolve themselves *quoquoversùm*, on all parts of the Concretion, into which they are admitted. And Geometry teacheth, that no figure is so easily moved, as a Sphere, whether naturally, or violently. First, *Naturally*; because, by how much neerer to a Sphere the figure of any solid body approacheth, by so much the more speedily doth it descend, as is observed of globular stones in Water: and a round stone rowles it self farther and swifter downe hill, than a plane or angular one. Secondly, *Violently*, because a globular stone may be projected much farther, than one of any other figure. This is also evident in the Motion of Volutation; so that the line of direction to the Centre of the World (if any such there be) consisting in the axis of the Globe, the motion of it is most hardly refracted and arrested. For, there are 3 points, thorowe which the direct imaginary line, in which alone a Globe can quiesce, must pass, *viz.* the *Centre of the World*, the *Centre of Gravity* in the Globe, and the *point of Contact*: and if either of these 3 be without, or beside the line of quiet, a Globe once moved shall never rest, but be continually moved, until all the 3 points be in the line of direction. Furthermore, how easie it is to impel a Globe, is demonstrable meerly from hence, that being posited upon a perfect plane, it can touch the same but only in one point; and so relying upon that point, may most easily be deturbed from that slender support; but in all other Figures the reason of innixion or Relying, is quite contrary. Lastly, as a sphere doth most easily admit an impreſt motion; so doth it longest retain the same, most violently press upon other occurring bodies, and most equally dispence its conceived force; as hath been profoundly demonstrated by *Magnenus* (*in theoricæ militaris lib.* 1. *theorem.* 4. *&* 5) (3) And that they must be also *superlatively swift in motion*, may be argued not only *à posteriori*, from the impetuous discussion and separation of the particles of bodies by them, and their unceſſant æstuation among themselves arietating each other: but also *à Priori*, because, being spherical, they are most mobile. Thus much, at least in importance, we have from *Philoponus* (*in* 1 *physic.*) where he saith, *Sphæricus Atomos, tanquàm facillimè mobiles, esse Caloris, ignisque caussas; quatenus enim sunt facilè mobiles, dividunt, subeuntque velociùs: id quippe ignis proprium est, & dividere, & moveri facilè posse.* And albeit *Plato* would not have the Atoms of Fire to be spherical, but *Pyramidal*; because having most exile points, slender angles, and acute sides, they might be more accommodate for Penetration or subingression: yet, to the *Division* or *Cutting* of bodies, He requires τῶν τε μορίων Σμικρότητα, καὶ τῆς φορᾶς τάχος. the Exiguity of particles, and celerity of Motion. So that the Patrons of Atoms præsuming the Calorifick Atoms to be extreamly Exile, *i.e* as small as *Plato* supposeth the points and angles of his Pyramids to be: we do not perceive any considerable difference betwixt their opinion and his. But before we take off our pen from this subject, we are to advertise; that indeed all Atoms, of their own nature, are inexcogitably swift; and so that our assertion of the superlative Velocity of Calorifick Atoms, doth appertain only to Atoms as they are in Concretions, where their native Velocity and Agility is retarded and diminished by reciprocal cohærence and revinction. And, therefore, seeing that all Atoms, agitated by their essential mobility, are in perpetual attempt to extricate themselves from Concretions, that so they may attain their primitive

mitive freedom of motion; that none can so soon extricate and disengage themselves; as those that are spherical; because such cannot be impeded by the small hooks, or angles of others. *Cum enim sphæra omnibus angulis careat, nihil hamati, aut retinentis offendet, facilè permeabit, & quoquoversus ad naturæ penetrabit instituta, dividet instar cunei, & (quod nulli alteri figuræ contingit) contactu puncti labefaciens planum, statim amplo sinu sibi viam facit, cum nihil habet angulosi, quo possit detineri; quod ejus activitati necessarium fuit:* saith *Magnenus* (*de Atom. lib.*2 *cap.*3.) As also, that we speak the Dialect of *Democritus*, when we call these Calorifick Atoms, sometimes the Atoms of *Heat*, sometimes the Atoms of *Fire*, indiscriminately; because Heat and Fire know none but a Gradual Difference; at least, because Heat, in a General sense, implies all degrees, and Fire, in a Special, the highest degree of Heat; *Aristotle* himself (1 *Meteor.*3) excellently defining Heat to be nothing else, but *Caloris Hyperbole*, the *Excess* of Heat.

Art. 7. That the Atoms of Heat are capable of *Expedition* or deliverance from Concretions, Two wayes; *viz.* by *Evocation* and *Motion.*

The Proprieties, or requisite Conditions of these Calorifick Atoms, being thus explored; our next Enquiry must be concerning the Manner of their *Emancipation*, or *Expedition* from the fetters of Concretions. We observe, therefore, that the Atoms of Fire, imprisoned in Concretions, have *Two* ways of attaining liberty. (1.) By *Evocation*, or the Assistance of other Atoms of the same nature; when such invading and insinuating themselves into the centrals of a body, do so dissociate its particles, as that dissolving the impediments or chains of the igneous Atoms therein contained, they not only give them an opportunity, but in a manner sollicite them to extricate themselves. And by this way do the Atoms of Fire, included in Wood, Wax, Turpentine, Oyle, and all other Inflammable Concretions, extricate themselves, when they are set on fire; the sparks or flame, wherewith they are accensed, penetrating their contexture, and removing the remoraes, which detained and impeded their internal Atoms of Fire, and exciting them to Emption: Which thereupon issue forth in swarms, and with the violence of their exsilition drive before them, in the apparence of fuliginous Exhalations or smoak, those dissimilar particles, which suppreſt and incarcerated them, during the integrity of the Concretion. (2.) By *Motion*, or *Concussion*; and that either Intestine, or External. First, *Intestine*; when, after many evolutions, the igneous Atoms, included in a Body, do of themselves dissociate and discuss those heterogeneous masses, wherein they were imprisoned: Which they chiefly effect, when after some of them have by spontaneous motion attained their freedom, if any thing be circumstant, which hath the power of repelling them, as cold; for, in that case, returning again into the centrals of the body, from whence they came; and so associating with their fellows, promote the discussion of the remaining impediments, and concur to a general Emption. From this Motion ariseth that Heat, or Fire, which is vulgarly ascribed to the *Antiperistasis*, or *Circumobsistence of Cold*; as, for Example, when a heap of new Corn, or Mowe of green Hay, being kept too close, during the time of its fermentation, or sweating (as our Husbandmen call it) sets it self on fire: the cold of the ambient aer, repelling the Atoms of Fire (which otherwise would expire insensibly) back again into it; and so causing them to unite to their fellows: and upon that consociation they suddainly engage in a general cumbustion, and dissolving all impediments, acquire their liberty. Hence also proceed all those Heats, which are observed

obſerved in Fermentation, Putrifaction and all other inteſtine Commotions and Mutations of Bodies.

Hither likewiſe would we refer that ſo generally believed Phænomenon, the *Warmneſs of Fountains*; Cellars, Mines, and all ſubterraneous Foſſes, *in Winter*: but that we conceive it not only ſuperfluous, but alſo of evil conſequence in Phyſiology, to conſign a Cauſe, where we have good reaſon to doubt the verity of the Effect. For, if we ſtrictly examine the ground of that common Aſſertion, we ſhall find it to conſiſt only in a miſinformation of our ſenſe; *i.e.* though Springs, Wells, Caves, and all ſubterraneous places are really as Cold in Winter, as Summer; yet do we apprehend them to be warm: becauſe we ſuppoſe that we bring the organs of the ſenſe of Touching alike diſpoſed in Winter and Summer, not conſidering that the ſame thing doth appear Cold to a hot, and warm to a Cold hand, nor obſerving, that oyle will be conglaciated, in Winter, in ſubterraneous Cells, which yet appear warm to thoſe, who enter them, but not in Summer, when yet they appear Cold. Secondly, by Motion *External*, when a Sawe grows Hot, by continuall affriction againſt wood, or ſtone; or when fire is kindled by the long and hard affriction of 2 dry ſticks, &c. This is manifeſt even from hence, that unleſs the bodies agitated, or rubbed againſt each other, are ſuch as contain igneous Atoms in them; no motion, however laſting and violent, can excite the leaſt degree of Heat in them. For, Water agitated moſt continently and violently, never conceives the leſt warmth: becauſe it is wholly deſtitute of Calorifick Atoms. Laſtly, as for the Heat, excited in a body, upon the Motion of its *Whole*, whether it be moved by it ſelf, or ſome External movent; of this ſort is that Heat, of which motion is commonly affirmed to be the ſole Cauſe: as when an Animal grows hot with running, &c. and a Bullet acquires heat in flying, &c. And thus much concerning the manner of Emancipation of our Calorifick Atoms.

Art. 8. An *Unctuous* matter, the chief *Seminary* of the Atoms of Heat: and why.

The next thing conſiderable, is their peculiar *Seminarie*, or *Conſervatory*; concerning which it may be obſerved, that the Atoms of Fire cannot, in regard of their extreme Exility, ſphærical Figure, and velocity of motion, be in any but an *Unctuous* and viſcous matter, ſuch whoſe other Atoms are more hamous, and reciprocally cohærent, than to be diſſociated eaſily by the inteſtine motions of the Calorifick Atoms; ſo that ſome greater force is required to the diſſolution of that unctuouſneſs and tenacity, whereby they mutually cohære. And hereupon we may ſafely conclude, that an Unctuous ſubſtance is as it were the chief, nay the ſole *Matrix*, or *Seminary* of Fire or Heat; and that ſuch Bodies only, as are capable of incaleſcence and inflammation, muſt contain ſomewhat of Fatneſs and unctuoſity in them. Sometimes, we confeſs, it is obſerved, that Concretions, which have no ſuch Unctuoſity at all in them, as Water, are Hot, but yet we cannot allow them to be properly ſaid to wax Hot, but to be made Hot; becauſe the principle of that their Heat is not Internal to them, but *External* or *Aſcititious*. For inſtance; when Fire is put under a veſſel of Water, the ſmall bodies, or particles of Fire by degrees inſinuate themſelves thorowe the pores of the veſſel into the ſubſtance of the Water, and diffuſe themſelves throughout the ſame; though not ſo totally, at firſt, as not to leave, the major part of the particles of the Water untoucht: to which

other igneous Atoms ſucceſſively admix themſelves, as the water grows hotter and hotter. And evident it is, how ſmall a time the Water doth keep its acquired heat, when once removed from the fire: becauſe, the Atoms of Heat being meerly Adventitious to it, they ſpontaneouſly deſert it one after another, and leave it, as they found it, Cold: only this Alteration, they cauſe therein, that they diminiſh the Quantity thereof, inſomuch as ſucceſſively aſcending into the aer, they carry along with them the more tenuious and moveable particles of the Water, in the apparence of vapours, which are nothing but Water Diffuſed, or Rarefied.

Art. 9. Among Unctuous Concretions, Why ſome are more eaſily inflammable than others.

But, if what we affirm, that only Unctuous Bodies are Inflammable, be generally true; whence comes it, *that amongſt Unctuous and Pinguous Concretions, ſome more eaſily take fire, than others?* The *Cauſe*, certainly is this, that the Atoms of Fire, incarcerated, in ſome Concretions, are not ſo deeply immerſt in, nor ſo oppreſt and overwhelmed with other Heterogenous particles of matter, as in others: and ſo acquire the liberty of Eruption much more eaſily. Thus dry Wood is ſooner kindled, than Green; becauſe, in the green, the Aqueous moyſture, ſurrounding and oppreſſing the Atoms of Fire therein contained, is firſt to be diſcuſſed and attenuated into vapours: but, in the Dry, time, by the mediation of the warmth in the ambient aer, hath already abſumed that luxuriant moyſture, ſo that none but the oleaginous, or unctuous part, wherein the Atoms of Fire have their principal reſidence, remains to be diſcuſſed; which done, the Atoms of Fire inſtantly iſſue forth in ſwarms, and diſcover themſelves in flame. Thus ſpirit of Wine is ſo much the ſooner inflammable, by how much the more pure and defæcated it is; becauſe the igneous Atoms therein concluded, are delivered from the greater part of that Phlegme, or aqueous humidity, wherewith they were formerly ſurrounded and oppreſt. On the contrary, a ſtone is not made Combuſtible without great difficulty; becauſe the ſubſtance of it is ſo compact, as that the Unctuous humidity is long in diſcuſſion. We ſay, a Stone, not a Peble, or Arenaceous one, becauſe ſuch is deſtitute of all Unctuoſity, and ſo of all igneous particles: but, a Limeſtone, ſuch as is capable of reduction to a Calx: or a Flint out of which by concuſſion againſt ſteel, are excuſſed many ſmall fragments, plentifully fraught with Atoms of Fire.

Art. 10. A CONSECTARY. That Rarefaction is the proper Effect of Heat.

The Nature and Origine of Heat being thus fully explicated, according to the moſt veriſimilous Principles of *Democritus*, *Epicurus*, and their Sectators; it follows, that we progreſs to thoſe *Poriſmata* or *Conſectaries*, which from thence reſult to our obſervation; and the *Solution* of ſome moſt conſiderable *Problems*, retaining to the ſame Argument, ſuch eſpecially as have hitherto eluded the ſolutive capacity of any other Hypotheſis, but what we have here aſſerted.

Inſomuch, therefore, as the Atoms of Heat, which are always incarcerated in an Unctuous Matter, doe, upon the acquiſition of their liberty, iſſue forth with violence, and inſinuating themſelves into

into Bodies, which they meet withal, and totally pervading them, diſſociate their particles, and diſſolve their Compage or Contexture: Hence is it manifeſt, that *Rarefaction*, or *Dilatation* is upon good reaſon accounted the proper Effect of Heat; ſince thoſe parts of a body, which are Conjoyned, cannot be Disjoyned, but they muſt inſtantly poſſeſs a greater part of ſpace (underſtand us in that ſtrict ſenſe, which we kept our ſelves to, in our Diſcourſe of Rarefaction and Condenſation) than before. Hence comes it, that Water in boyling, ſeems ſo to be encreaſed, that what, when cold, filled ſcarce half the Caldron, in ebullition cannot be contained in the whole, but ſwells over the brim thereof. Hence is it alſo, that all bodies attenuated into Fume, are diffuſed into ſpace an hundred, nay ſometimes a thouſand degrees larger than what they poſſeſſed before.

Art. 11. PROBLEM I. Why the bottom of a Caldron, wherein Water is boyling, may be touched by the hand of a man, without burning it: Sol.

From this Conſectary we arrive at ſome *Problems*, which ſtand directly in our way to another; and the *Firſt* is that Vulgar one, *Why the bottom of a Caldron, wherein Water, or any other Liquor is boyling, is but moderately warm, at moſt not ſo hot, as to burn a mans hand applyed thereto?*

The Cauſe of this culinary Wonder (ſo our Houſewifes account it) ſeems to be this; when the Atoms of Heat, paſſing through the pores in the bottom of the Caldron into the water, do aſcend through it, they elevate and carry along with them ſome particles thereof: and at the ſame time, other particles of Water, next adjacent to them, ſink down, and inſtantly flowe into the places deſerted by the former, which aſcended, and inſinuate themſelves into the now laxarated pores in the bottom of the caldron. And though theſe are ſoon repelled upwards by other Atoms of Fire aſcending thorowe the pores of the Veſſel, and carried upwards, as the former, yet are there other particles of Water, which ſinking down, inſinuate alſo into the open pores of the veſſel, and by their conflux or downward motion, much refract the violence of the ſubingredient Atoms of Fire: and ſo, by this viciſſitude of Heat and Moyſture, it comes to paſs, that the Heat cannot be diffuſed throughout the bottom of the Caldron, the Humidity (which falls into the pores of it in the ſame proportion, as the Heat paſſeth thorow them) hindering the poſſeſſion of all its empty ſpaces by the invading Atoms of Fire. Nor doth it availe to the contrary, that the Water which inſinuates into the pores of the veſſel, is made Hot, and ſo muſt calefie the ſame, in ſome proportion, as well as the Fire underneath it; becauſe boyling Water poured into a cold Caldron, doth more than warm it: For, thoſe particles of Water, which ſucceſſively enter into the void ſpaces of the veſſel, are ſuch as have not yet been penetrated *per minimas*, by the Atoms of Fire. For, all the cold, formerly entered into the water, is not at once diſcuſſed, though the Water be in boyling; the Ebullition ariſing only from the cohærence of the calefied with the uncalefied particles of the Water. And from the ſame Cauſe is it, that a ſheet of the thinneſt Venice Paper, if ſo folded upward in its Margines, as to hold Oyle infuſed into it, and laid upon a gridiron over burning coals; doth endure the fire without inflammation for a good ſpace:

Which ſome Cooks obſerving, uſe to fry Bacon upon a ſheet of Paper only.

Art. 12. PROBLEM 2. Why Lime becomes ardent upon the affuſion of Water. Sol.

Secondly, *Why doth Lime acquire an Heat and great Ebullition upon the affuſion of Water? ſince, if our præcedent Aſſertion be true, the Heat included in the Lime ought to be ſuppreſt ſo much the more, by how much the more Aqueous Humidity is admixt unto it.*

This Difficulty is diſcuſſed by Anſwering; that the Aqueous Humidity of the Lime-ſtone is indeed wholly evaporated by fire in its calcination; but yet the Pingous, or Unctuous for the moſt part remains, ſo that its Atoms of Fire lye ſtill blended and incarcerated therein: and when thoſe expede themſelves, and by degrees expire into the ambient aer, if they be impeded and repelled by water affuſed, they recoyle upon the grumous maſſes of the Lime, and by the Circumobſiſtence of the Humidity, become more congregated; and ſo upon the uniting of their forces make way for the Exſilition of the other Atoms of Fire, which otherwiſe could not have attained their liberty but ſlowly and by ſucceſſion one after another. So that all the Atoms of Fire contained in the Lime, iſſuing forth together, they break through the water, calefie it, and make it bubble or boyle up; the calefied parts thereof being yet cohærent to the uncalefied.

Art. 13. PROBLEM 3. Why the Heat of *Lime* burning is more vehement, than the Heat of any *Flame* whatever. Sol.

The Third Problem is, *Why the Heat of Lime, kindled by Water is more intenſe than that of any Flame whatever?*

Anſwer, that foraſmuch as Flame is nothing but Fire Rarefied, or as it were an Explication, or Diffuſion of thoſe Atoms of Fire, which were lately ambuſcadoed in ſome Unctuous matter; and that all Fire is ſo much more intenſe or vehement, by how much more Denſe it is, *i.e.* by how much the more congregated the Atoms which conſtitute it are: therefore is the Heat of Lime unſlaking more vehement than that of any Flame, in regard the ſmalleſt grains of Lime contain in them many Atoms of Fire, which are not ſo diffuſed or diſgregated in a moment, as thoſe in Flame. So that a mans hand being waved to and fro in Flame, is invaded by incomrably fewer particles of Fire, than when it is dipt into, or waved through water at the unſlaking of Lime thereby; the ſmall granes of Lime adhæring unto, and inſinuating into the pores of the hand, the many Atoms of fire invelloped in them, incontinently explicate themſelves, violently penetrate and dilacerate the skin, and other ſentient parts, and ſo produce that Pungent and Acute pain, which is felt in all Ambuſtions. From the ſame Reaſon alſo is it, that a glowing Coale burns more vehemently than Flame: and the Coals of more ſolid wood, as Juniper, Cedar, Guaiacum, Ebony, Oke, &c. more vehemently than thoſe of Looſer wood, ſuch as Willow, Elder, Pine tree, &c. The like Diſproportion is obſervable alſo in the Flames of divers Fewels; for in the flame of Juniper are contained far more Igneous Atoms, than in that of Willow: and conſequently they burn ſo much more vehemently. True it is, that ſpirit of Wine enflamed, is ſo much more Ardent, by how much more refined and cohobated: yet this proceedeth from another Cauſe; *viz.* that the Atoms of Fire iſſuing from ſpirit of Wine of the firſt Extraction, have much of the Phletegme, or Aqueous moyſture of the Wine intermixt among them; and ſo cannot be alleaged

as

as an Example that impugne's our Reason of the Different Heats of several Flames.

The *Fourth*, is that Vulgar Quære, *Why boyling Oyle doth scald more dangerously, than boyling Water?*

Art. 14. PROBLEM 4: Why boyling *Oyle* scalds more vehemently, then boyling *Water*. Sol.

To which it is easily Answered; that Oyle, being of an Unctuous and Tenacious consistence, and so having its particles more firmly cohærent, than Water, doth not permit the Atoms of Fire entered into it, so easily to transpire: so that being more agminous, or swarming in oyl, they must invade, and dilacerate the hand of a man, immersed into it, both more thickly and deeply, than those more Dispersed ones contained in boyling Water. Which is also the Reason, why Oyle made fervent is much longer in cooling, than Water: and may be extended to the Solution of the

Fifth Problem, *viz. Wherefore do Metals, especially Gold, when melted, or made glowing hot, burn more violently, than the Fire that melteth, or heateth them; especially, since no Atoms of Fire can justly be affirmed to be lodged in them, as in their proper seminary, and so not to be educed from them, upon their Liquation, or Ignition.*

Art. 15. PROBLEM 5: Why *Metals*, melted or made red hot, burn more violent than the Fire, that melteth or heateth them; Sol.

For, the Heat, wherewith they procure Ambustion, being not domestick, but only Adventitious to them from the Fire, wherein they are melted, or made red hot; the reason why they burn so extreamly, must be this, that they are exceedingly Compact in substance, and so their particles being more tenacious or reciprocally cohærent, then those of wood, oyle, or any other body whatever, they more firmly keep together the Atoms of fire immitted into them: insomuch that a man cannot touch them with his finger, but instantly it is in all points invaded with whole swarms of igneous Atoms, and most fiercely compunged and dilacerated. And, as for the *Derasion of the skin* from any part of an Animal, immersed into melted metal; this ariseth partly from the total dissolution of the tenour of the skin by the dense, and on every side compungent Atoms of Fire; partly from the Compression and Resistence of the parts of the Metal, now made Fluid, which are both so great, that upon the withdrawing of the member immersed into the metal, the part which is immediately prest upon by the particles thereof, is detained behind, and that's the skin. Hence also is it no longer a Problem, *Why red hot Iron sets any Combustible matter on Fire*; for it is evident, that it cannot inflame by its own substance, but by the Atoms of Fire immitted into, and for a while reteined in its Pores. And this brings us to a

Second CONSECTARY, *viz.* That as the Degrees of Heat are various (Physicians, indeed, allow only 4, and Physiologists but double that number; the Former, in order to the more convenient reduction of their Art to certain and established principles; the Latter, meerly in conformity to the Dictates of *Aristotle*: but Neither upon absolute necessity, since it is reasonable for any man to augment their number even above number, at pleasure) So also must the *Degrees of fire be various*. For, since Fire, even according to *Aristotle* is only the Excess of Heat, or Heat encreased to that height, as to Burn, or Enflame a thing; if we begin at the gentle Meteor called

Art. 16. CONSECTARY 2. That, as the degrees of Heat, so those of fire are innumerably various.

called *Ignis Fatuus* (which lighting upon a mans hand, and a good while adhereing thereto, doth hardly warm it) or at the fire of the pureſt ſpirit of Wine enflamed (which alſo is very languid, for it is frequent among the Iriſh, for a Cure of their Endemious Fluxes of the belly, to ſwallow down ſmall balls of Cotton, ſteept in ſpirit of wine, and ſet on fire, and that many times with good ſucceſs.) We ſay, if we begin from either of theſe weak Fires, and run through all the intermediate ones, to that of melted Gold, which all men acknowledge to be the Higheſt: we ſhall ſoon be convinced, that the Degrees of Fire are ſo various, as to ariſe even to innumerability.

Art. 17. That to the Calefaction, Combuſtion, or Inflammation of a body by fire, is required a certain ſpace of time; and that the ſpace is greater or leſs, according to the paucity, or abundance of the igneous Atoms invading the body obiected; and more or leſs of aptitude in the contexture thereof to admit them.

Moſt true it is, in the General, that every Fire is ſo much the more intenſe, by how much more numerous, or agminous the Atoms of Fire are, that make it: yet, if we regard only the Effect, there muſt be allowed a convenient ſpace of time, for the requiſite motion of thoſe Atoms, and a ſupply of freſh ones ſucceſſively to invade and penetrate the thing to be burned or enflamed. For, ſince the Igneous Atoms, exſilient from their involucrum, or ſeminary, and invading the extrems of a body objected to them, are ſubject to eaſy Repercuſſion, or (rather) Reſilition from it; therefore, to the Calefaction, Aduſtion, or Inflammation of a body, it is not ſufficient, that the body be only moved along by, or over the Fire: but it muſt be held neer, or in it, ſo long as till the firſt invading Igneous Atoms, which otherwiſe would recoyle from it, be impelled on, and driven into the pores of the ſame, by ſtreams of other Igneous Atoms contiguouſly, ſucceeding and preſſing upon them. And, however the ſpace of time, be almoſt in aſſignably ſhort, in which the finger of a man, touching a glowing Coale, or melted metal, is burned; becauſe, the Atoms of Fire are therein exceeding Denſe and Agminous, and ſo penetrate the skin, in all points: yet nevertheleſs common obſervation aſſures, that in the General a certain ſpace of time is neceſſary to the Effect of Calefaction or Ambuſtion; and that ſo much the Longer, by how much the Fewer, or more Diſgregated the Igneous Atoms are, either in the Body Calefying, or the Aer conterminous thereto. And this (as formerly) to the end, that the Motion of the Igneous Atoms firſt aſſaulting the object may be continued, and a ſupply of freſh ones, promoting and impelling the former, be afforded from the Focus, or Seminary. Hence is it, that a mans hand may be frequently Waved to and fro in Flame, without burning; becauſe the Atoms of Fire, which invade it, are repercuſſed, and not by a continued aflux of others driven foreward into its pores, the motion of his hand preventing the Continuity of their Fluor: but, if his hand be held ſtill in the flame, though but a very ſhort time, it muſt be burned; becauſe the firſt invading Atoms of Fire are impelled on by others, and thoſe again by others, in a continent fluor, ſo that their Motion is continued, and a conſtant ſupply maintained. Hence comes it alſo, that no Metal can be molten only by a Flaſh, or tranſient touch of the Fire (for, we are not yet fully ſatisfied of the verity of that vulgar tradition, of the inſtantaneous melting of money in a purſe, or of a ſword blade in its ſheath, by Lightning: and if we were, yet could we aſſign that prodigious Effect to ſome more propable Cauſe; *viz.* the impetuoſity of the motion, and the exceeding Coarctation of thoſe Atoms of Fire, of which that peculiar ſpecies of Lightning doth conſiſt) but it muſt be ſo long held in, or over the Fire, as until the Igneous Atoms have totally pervaded its contexture, and diſſo-

diſſociated all its particles: and therefore, ſo much the longer ſtay in the fire doth every Metal require to its Fuſion; by how much the more Compact and Tenacious its particles are.

As the Degrees of Fire are various, as to the more and leſs of Vehemency, reſpective to the more and leſs Denſity, or Congregation of the Igneous Atoms: So likewiſe is there a conſiderably variety among Flames, as to the more and leſs of *Duration.* Concerning the *Cauſes*, therefore of this Variety, in the General, we briefly obſerve; that Flame hath its Greater or Leſs Duration, reſpective to the

Art. 18. *Flame* more or leſs *Durable*, for various reſpects.

(1.) *Various Materials, or Bodies inflammable.* For, ſuch Bodies, as have a greater Averſion to inflammation, being commixt with others, that are eaſily inflammable, make their flame leſs Durable; as Bay Salt, diſſolved in ſpirit of Wine, ſhortens the duration of its flame, by almoſt a third part, as the *Lord Bacon* affirms upon exact experiment (*Nat. Hiſt. cent.* 4.) and contrariwiſe, ſuch as approach neerer to an affinity with fire, *i.e.* have much of Unctuouſneſs, and plenty of igneous Atoms concealed therein, yield the moſt laſting Flames; as Oyle and Spirit of Wine commixt in due proportions; and ſpirit of Salt, to a tenth part, commixt with Oyle Olive, makes it burn twice as long in a Lamp, as Oyle alone, from whence ſome Chymiſts have promiſed to make Eternal Lamps with an Oyle extracted from common Salt, and the ſtone Amianthus.

(2.) *The more or leſs eaſie Attraction of its Pabulum, or Nouriſhment.* For, Lamps, in which the Flame draweth the oyle from a greater diſtance, always burn much longer, than Candles, or Tapers, where the circumference of the fewel is but ſmall; and the broader the ſurface of the Oyle, or Wax, wherein the Wiek is immerſed, ſo much the longer doth the flame thereof endure; not only in regard of the greater Quantity of Nouriſhment, but of its ſlower Calefaction, and ſo of its longer Reſiſtence to the abſumptive faculty of the flame. Since it is obſerved, that the Coolneſs of the Nouriſhment, doth make it more ſlowly conſumable: as in Candles floating in water. This was experimented in that ſervice of our *quondam* Engliſh Court, called *All night*; which was a large Cake of Wax, with the Wiek, ſet in the middeſt: ſo that the flame, being fed with nouriſhment leſs heated before hand, as coming far off, muſt of neceſſity laſt much longer, than any Wax Taper of a ſmall circumference.

(3) *Various Conditions of the ſame Materials.* For, Old and Hard Candles, whether of Wax, or Tallowe, maintain flame much longer than New, or ſoft. Which good Houſwives knowing, uſe no Candles under a year old, and ſuch as have, for greater induration, been laid a good while in Bran, or Flower. And, from the ſame reaſon is it, that Wax, as being more firm and hard, admixt to Tallowe and made up into Candles, cauſeth them to be more laſting, then if they were præpared of Tallowe alone.

(4.) *Different Conditions, and Tempers of the ambient Aer.* For, the Quiet and Cloſeneſs of the Aer, wherein a Taper burneth, much conduceth to the prolongation of its flame: and contrariwiſe, the Agitation thereof,

thereof, by winds, or fanning, conduceth as much to the ſhortning of it: inſomuch as the motion of flame makes it more greedily attract, and more ſpeedily devour its ſuſtenance. Thus a Candle laſteth much longer in a Lanthorne, than at large in a ſpacious roome. Which alſo might be aſſigned as one Cauſe of the long Duration of thoſe ſubterranean Lamps, ſuch as have been found (if credit be due to the tradition of *Bapt. Porta*, (*lib.*12 *Magiæ natural. cap.ultim.*) *Hermolaus Barbarus* (*in lib.*5.*Dio cap.* 11.) *and Cedrenus* (*Hiſtor.Compend.*) All which moſt confidently avouch it, upon authentique teſtimonies.) in the Urns of many Noble Romans, many hundreds of years after their Funerals. Here ſhould our Reader bid us ſtand, and deliver him our poſitive judgement, upon this ſtupendious Rarity, which hath been uged by ſome Laureat Antiquaries, as a cheif Argument of the tranſcendency of the Ancients Knowledge as in all Arts, ſo in the admirable ſecrets of Pyrotechny, above that of Later Ages; as we durſt not be ſo uncharitable, to quæſtion the Veracity of either the Inventors, or Reporters of it: ſo ſhould we not be ſo uncivil, as not to releive his Curioſity, at leaſt with a ſhort ſtory, that may light Him towards farther ſatisfaction. A certain *Chymiſt* there was, not many years ſince, who having decocted Litharge of Gold, Tartar, Cinnaber, and Calx vive, in ſpirit of Vinegre, until the Vinegre was wholly evaporated; cloſely covering and luting up the earthen veſſel, wherein the Decoction was made, buried it deeply in a dry Earth, for 7 moneths together (in order to more ſpeedy maturation, expected from the Antiperiſtaſis of Cold) came at length to obſerve what became of his Compoſition: and opening the veſſel, obſerved a certain bright Flame to iſſue from thence, and that ſo vehement, as it fired the hair of his eyebrowes and head. Now, having furniſhed our Reader with this faithful Narrative; we leave it to his owne determination: Whether it be not more probable, that thoſe Coruſcations, or Flaſhes of Light, perceived to iſſue from Vials of Earth, found in the demoliſht ſepulchres of the Great *Olybius*, and ſome eminent Romans, at the inſtant of their breaking up by the ſpade, or pickaxe; did proceed rather from ſome ſuch Chymical Mixture, as this of our Chymiſt (who acquired Light by the hazard of Blindneſs) which is of that nature as to be in a moment kindled, and yield a ſhortlived flame, upon the intromiſſion of Aer into the veſſel, wherein it is contained; than from any Fewel, that is ſo ſlowly Abſumable by Fire, as to maintain a conſtant Flame, for many hundred years together, without extinction, and that in ſo ſmall a vial, as the Fume muſt needs recoyle and ſoon ſuffocate the Flame. But we return from our Digreſſion, and directly purſue our emboſt Argument. It much importeth the greater and leſs Continuance of Flame, whether the Aer be *Warm*, or *Cold*, *Dry* or *Moiſt*. For *Cold* Aer irritateth flame, by Circumobſiſtence, and cauſeth it burn more fiercely, and ſo leſs durably; as is manifeſt from hence, that Fire ſcorcheth in froſty weather: but *Warme* Aer, by making flame more calm and gentle, and ſo more ſparing of its nouriſhment, much helpeth the Continuance of it. If *Moiſt*, becauſe it impedeth the motion of the igneous Atoms, and ſo in ſome degree quencheth flame, at leaſt, makes it burn more dimly and dully; it muſt of neceſſity advance the Duration of flame: and contrariwiſe, *Drie* Aer, meerly as drie, produceth Contrary Effect, though not in the ſame proportion; nay ſo little, that ſome Naturaliſts have concluded the Drineſs of Aer to be only indifferent, as to the Duration of Flame.

And

And now we are arrived at our Third and Last CONSECTARY; That the *immediate and genuine Effect of Heat, is Disgregation*, or *Separation:* and that it is only by Accident that Heat doth Congregate Homogeneous natures. To argue by the most familiar way of Instance; when Heat hath dissolved a piece of Ice, consisting of water, earth, and perhaps of gravel and many small Festucous bodies commixt; the Earth, Sand and other Terrene parts sink downe and convene together at the bottom, the water returns to its native fluidity, and possesseth the middle region of the Continent, and the strawes swim on the surface of the water: not that it is essential to the Heat so to dispose them; but essential to them, being dissociated and so at liberty, each to take it proper place, according to the several degrees of their Gravity. Thus also, when a Mass of various Metals is melted by Fire, each metal, indeed, takes it proper region in the Crucible, or fusory vessel: but yet the Congregation of the Homogeneous particles of each particular Metal, is not immediately caused, but only occasioned, *i. e.* Accidentally brought to pass by the Disgregation or præcedent separation of the particles of the whole Heterogeneous Concretion, by heat. Again, the Energy of every Cause in Nature ceaseth, upon the production of its perfect Effect; but the Effect of Heat ceaseth not, when the Homogenieties of the mass of Ice, or Metal, are Congregated, but continues the same after, as before, *i.e.* to Dissolve the compage of the Metal, or Ice, and Dissociate all the particles thereof: for, so long as the Heat is continued, so long do the Ice and Metal remain Dissolved and Fluid. This considered, what shall we say to *Aristotle*, who makes it the Essential Attribute of Heat, *Congregare Homogenea*, to Congregate Homogeneous Bodies. Truly, rather then openly convict so great a Votary to truth of so palpable an Error; we should gladly become his Compurgator, and palliate his mistake with an indulgent comment; that in his Definition of Heat, to be a Quality genuinely Congregative of Homogeneous natures, He had his eye, not upon the General Effect of Heat (which He could not but observe, to Disgregate the particles of all things, aswel Homogeneous, as Heterogeneous.) but upon some special Effect of it upon some particular Concretions, such as are Compounded of parts of Divers natures, as Wood and all Combustible bodies. Concerning which, indeed, His Assertion is thus far justifiable, that the whole Bodie is so dissolved by fire, as that the Dissimilar parts of it are perfectly sequestred each from other, and every one attains it proper place; the Aereal part ascending and associating with the Aer, the Aqueous evaporating, the Igneous discovering themselves in Flame, and the earthy remaining behind, in the forme of Ashes. But alas! this favourable Conjecture cannot excuse, nor gild over his Incogitancy; for, the Congregation of the Homogenous particles of a Body, dissolved by Fire, in the place most convenient to their particular Nature, ariseth immediately from their own Tendency thither, or (that we may speak more like our selves, *i. e.* the Disciples of *Epicurus*) from their respective proportions of Gravity, the more Heavy extruding and so impelling upward the less heavy: and only Accidentally from Heat, or as it hath dissolved the cæment, and so the Continuity of the Concretion, wherein they were confusedly and promiscuously blended together. So that Truth will not dispense with our Connivence at so dangerous a Lapse, though in one of Her choicest Favorites; chiefly, because it hath already deluded so

Art. 19. CONSECTARY 3. That the immediate and genuine Effect of Heat, is the *Disgregation* of all bodies, as well Homogeneous, as Heterogeneous; and that the *Congregation* of Homogeneous Natures, is only an *Accidental* Effect of Heat; contrary to *Aristotle*.

ſo many of Her ſeekers, under the glorious title of a Fundamental Axiome: but ſtrictly enjoynes Us, to Conclude; that Heat, *per ſe*, or of its own nature, is alwayes a *Diſgregative Quality*; and that it is of of meer Accident, that upon the ſequeſtration of Heterogeneities, Homogeneous Natures are aſſociated, rather than, *è contra*, that it is of meer Accident, that while Heat Congregates Homogeneous, it ſhould Diſgregate Heterogeneous Natures, as *Ariſtotle* moſt inconſiderat ely affirmed and taught.

Sect. II.

Art. 1. The Link connecting this Section to the former.

As in the Courſe, ſo in the Diſcourſe of Nature, having done with the principle of Life, Heat, we muſt immediately come to the principle of Death, COLD: whoſe Eſſence we cannot ſeaſonably explain, before we have proved, that it hath an Eſſence; ſince many have hotly, though with but cold Arguments, contended, that it hath none at all, but is a meer Privation, or Nothing.

Art. 2. That Cold is no *Privation* of Heat; but a *Real* and *Positive Quality*: demonſtrated.

That Cold, therefore, is a *Real Ens*, and hath a *Poſitive Nature* of its own, may be thus demonſtrated. (1.) Such are the proper Effects of Cold, as cannot, without open abſurdity, be aſcribed to a ſimple Privation; ſince a Privation is incapable of Action: for, Cold compingeth all Bodies, that are capable of its efficacy, and congealeth Water into Ice, which is more than ever any man durſt aſſigne to a privation. And, when a man thruſts his hand into cold Water, the Cold He then feels, cannot be ſayd to be a meer privation of the Heat of his hand; ſince, his hand remains as Hot, if not hotter than before; the Calorifick Atoms of his hand being more united, by the circumobſiſtence of the Cold. (2.) All Heat doth Concentre and unite it ſelf, upon the Antiperiſtaſis of Cold; not from fear of a privation, becauſe Heat is deſtitute of a ſenſe of its owne being, and ſo of fear to loſe that being; and if not, yet Nothing can have no Contrariety, nor Activity: but, from Repulſion, as we have formerly delivered. (3.) Though many bodies are obſerved to become Cold, upon the abſence, or Expiration of Heat: yet is it the intromiſſion of the Quality contrary to Heat, that makes them ſo; for, if External Cold be not introduced into their pores, they cannot be ſo properly ſayd, *Frigeſcere*, to wax Cold, as *Decaleſcere*, to wax leſs Hot. Thus a ſtone, which is not Hot, nor Cold, unleſs by Accident, being admoved to the fire, is made Hot; and removed from the fire, you cannot (unleſs the ambient Aer intromit its Cold into it) ſo juſtly ſay, that it growes Cold, as that it grows Leſs hot, or returnes to its native ſtate of indifferency. (4.) When Water (vulgarly, though untruely præſumed to be naturally or eſſentially cold) is congealed into Ice by the Cold of the aer, it would be moſt ſhamefully abſurd, to affirm, that the Cold of the Ice ariſeth meerly from the Abſence of Heat in the water; becauſe it is the eſſential part of the ſuppoſition, that the Water had no Heat before. (5.) Privation knowes no Degrees; for the Word imports the totall Deſtitution, or Abſence of ſomewhat formerly

formerly had, otherwise, in rigid truth, it can be no Privation (and therefore our common Distinction of a Partial, and Total privation, hath lived thus long meerly upon indulgence and tolleration.): but Cold hath its various Degrees, for Water is colder to the touch than Earth, Ice than Water, &c. therefore Cold is no Privative, but *a Positive Quality.*

Art. 3. That the adæquate *Notion* of Cold, ought to be desumed from its *General Effect*, viz. the *Congregation* and *Compaction* of bodies.

The Reality of Cold being thus clearly evicted, we may, with more advantage undertake the consideration of its *Formality*, and explore the roots of those Attributes commonly imputed thereunto.

First, therefore, we observe; that though Cold be Scholastically defined by that passion caused in the organs of the sense of touching, upon the contact of a Cold object; yet doth not that special Notion sufficiently express its Nature: because there is a more *General Effect* by which it falls under our cognizance; and that is the *Congregation* and *Compaction* of the parts of bodies. For, since Cold is the Antagonist to Heat, whose proper vertue it is, to Discuss and Disgregate; therefore must the proper and immediate virtue of Cold be, to *Congregate* and *Compinge*: and consequently, ought we to form to our selves a notion of the Essence of Cold, according to that general Effect, rather than that special one produced in the sense of Touching, which doth adumbrate only a Relative part of it.

Art. 4. Cold, no Immaterial; but a *Substantial* Quality.

Secondly, that by *Cold*, we understand not any *Immaterial Quality*, as *Aristotle* and the *Schools* after him; but a *Substantial* one, *i.e. certain particles of Matter, or Atoms whose determinate Magnitude and Figure adapt or empower them to congregate and compinge bodies, or to produce all those Effects observed to arise immediately from Cold.* And, as the *Atoms*, which are comparated to the Causation of such Effects, may rightly be termed, the *Atoms of Cold*, or *Frigorifick Atoms*: so may those *Concretions*, which harbour such Atoms, and are capable of Emitting them, be named *Cold Concretions*; either *Actually*, as Frost, snowe, the North-wind, &c. or *Potentially*, as Nitre, Hemlock, Night-shade, and all other simples aswel Medical, as Toxical or Poysonous, whose Alterative Virtue consisteth cheifly in Cold.

Art. 5. *Gassendus* conjectural Assignation of a *Tetrahedical* Figure to the Atoms of cold; asserted by sundry weighty considerations.

Now, as for the determinate *Figure* of Frigorifick Atoms; our enquiries can hope for but small light from the almost consumed vaper of Antiquity: For, though *Philoponus* (*in* 1 *physic.*) *&* *Magnenus* (*de Atomis, disput.* 2. *cap.*3.) confidently deliver, that *Democritus* assigned a *Cubical* Figure to the Atoms of Cold; and endeavour to justifie that assignation, by sundry Mathematical reasons: yet *Aristotle*, a man aswell acquainted with the doctrines of his Predecessors, as either of those, expressly affirms, that nor *Democritus*, nor *Leucippus*, nor *Epicurus* determined the Atoms of Cold to any particular Figure at all; for, His words are these (3 *de cælo*, *cap.* 4.) οὐκ ἔτι ἐπιδιώρισαν, *Nihilpendè determinarunt.* So, that rather than remain altogether in the dark, we must strike fire out of that learned Conjecture of our Master *Gassendus*; and taking our indication from the rule of Contrariety, infer, that the Atoms of Heat being spherical, those of Cold, in all reason, must be *Tetrahedical*, or Pyramidal, consisting of 4 sides, or equilateral Triangles. To make the reasonableness of this supposition duly evident, let us consider

consider (1.) That as Heat hath its origine from Atoms most exile in magnitude, spherical in figure, and so most swift of motion: so must its Contrary, Cold, be derived from principles of Contrary proprieties, *viz.* Atoms not so exile in magnitude, of a Figure most opposite to a sphere, and so of most slow motion. (2.) That none but *Tetrahedical* Atoms can justly challenge to themselves these proprieties, that are requisite to the Essensification of Cold. For (1.) If we regard their *Magnitude*, a Tetrahedical Atom may be Greater than a Spherical, by its whole Angles: because a Sphere may be circumscribed within a Tetrahedon. (2.) If the *Figure* it self; none is more opposed to a Sphere, than a Tetrahedon: because it is Angular, and farthest recedeth from that infinity, or (rather) innumerability of small insensible sides, which a profound Geometrician may speculate in a Sphere. (3.) If their *Mobility*; no body can be more unapt for motion, than a Tetrahedical one: for, what vulgar Mathematicians impute to a Cube, *viz.* that it challengeth the palme from all other Figures, for Ineptitude to motion, doth indeed more rightfully belong to a Tetrahedon; as will soon appear to any equitable consideration, upon the perpension of the reasons alleagable on both parts. But here we are to signifie, that this ineptitude to motion proper to Tetrahedical Atoms, is not meant of Atoms at liberty, and injoying freedom of motion, in the Inane space; since, in that state all Atoms are præsumed to be of equal velocity: but only of Atoms wanting that liberty, such as are included in Concretions, and by intestine evolutions continually attempt Emancipation and Exsilition. (4.) It cannot impugne, at least, not stagger the reasonableness of this conjectural Assignation of a Tetrahedical figure to the Atoms of Cold, that *Plato* (*in Timæo*) definitely adscribeth a *Pyramidal Figure* to Fire, not to the Aer, *i.e.* to the Atoms of Heat, not to those of Cold: because, if any shall thereupon conceive, that a Pyramid is most capable of penetrating the skin of a man, and consequently of producing therein the sense of Heat, rather than Cold; He may be soon converted by considering a passage in our former section of this Chapter, that the Atoms of Heat may, though spherical, as well in respect of their extreme Exility (which the point of no Pyramid can exceed) as of the velocity of their Motion, prick as sharply, and penetrate as deeply, as the Angles of the smallest Pyramid imaginable. To which may be conjoyned, that the Atoms of Cold, according to our supposition, are also capable of Pungency and Penetration; and consequently that a kind of Adustion is also assignable to great Cold; according to that expression of *Virgil* (1 *Georg.*) *Bocea penetrabile frigus adurit.* For, in fervent Frosts (to use the same Epithite, as the sweet-tongued *Ovid*, in the same case) when our hands are, as the English phrase is, Benumm'd with Cold; if we hold them to the fire, we instantly feel a sharp and pricking pain in them. Which ariseth from hence, that the Atoms of Heat, while by their agility and constant supplies they are dispelling those of Cold, which had entred and possessed the pores of our hands, do variously commove and invert them; they are hastily driven forth, and in their contention and egress, cut and dilacerate the flesh and skin, as well with their small points, as edges lying betwixt their points, and so produce an acute and pungitive pain. Whereupon the sage *Sennertus* (*de Atomis*) grounds his advice, that in extreme cold weather, when our hands are so stupified, as that an Extinction of their vital heat may be feared; we either immerse them into cold water, or rub them in snow, that the Atoms of Cold, which have wedged each other into

into the pores, may be gently and gradually called forth, before we hold them to the fire: and this, least not only grievous pain be caused, but a Gangrene ensue, from the totall dissolution of the Contexture of our hands by the violent intrusion of the Cold Atoms, when they are forcibly impelled and agitated by the igneous; as the sad experience of many in *Ruscia*, *Groenland*, the *Alps*, and other Regions obnoxious to the tyranny of Cold, hath taught. Concerning this, *Helmont* also was in the right, when He said, *Mechanicè namque videmus, membrum fere congelatum sub nive recalescere, & à sideratione præservari; quod aliàs aer mox totalitèr congelare pergeret, vel si repentè ad ignem sit delatum, moritur propter extremi alterius festinam actionem, &c.* (*in cap. de Aere articul* 8.) (5.) Nor doth it hinder, that *Philoponus* and *Magnenus* affirm, that the Atoms of Cold ought to be *Cubical*, in respect of the eminent aptitude of that figure, for Constipation and Compingency, the General Effects of Cold: because, a Pyramid also hath its plane sides, or faces, which empower it to perform as much as a Cube, in that respect; and if common Salt be Constrictive, only because, being Hexahedrical in form, it hath square plane sides, as a Cube; certainly Alum must be more Constrictive, because being Octahedrical in form, it hath triangular plane sides, as a Pyramid. Besides, it is manifest, that these plane sides must so much the more press upon and wedge in the particles of a body, by how much more of the body, or greater number of its particles they touch: and that by how much more they are entangled by their Angles, so much more hardly are they Expeded, and so remain cohærent so much more pertinaciously. Hence comes it, that all Concretions consisting, for the most part, of such figurated Atoms, are *Adstrictive Effectually*: for, interposing their particles amongst those of other bodies, that are Fluid; they make their Consistence more Compact and somewhat Rigid, as in Ice, Snow, Haile, Hoar-frost, &c.

Art. 6. Cold, not *Essential* to Earth, Waters, nor Aer.

The Consignation of a Tetrahedical Figure to Frigorifick Atoms appearing thus eminently verisimilous; to the full Explanation of the Nature of Cold, it remains only, that we decide that notable *Controversy*, which so much perplexed many of the Ancients: *viz. Whether Cold be an Elementary Quality*; or (more plainly) *Whether or no the Principality of Cold belongs to any one of the four vulgar Elements; and so whether Aer, or Water, or Earth may not be conceived to be Primum Frigidum, as rightfully as Fire is sayd to be Primum Calidum?* Especially, since it is well known, that the *Stoicks* imputed the principality of Cold to the *Aer*; *Empedocles* to *Water*, to whom *Aristotle* plainly assented, though He sometimes forgot himself, and affirmed that no Humor is without Heat (as *in* 5. *de Generat. Animal. cap.* 2.); and *Plutarch* to *Earth*, as we have learned from Himself (*lib. de frigore primigenio.*)

To determine this Antique Dispute, therefore, we first observe; that it arose cheifly from a *Petitionary* Principle. For it appears, that all Philosophers, who engaged therein, took it for granted, that the Quality of Heat was eminently inhærent in Fire, the chief of the 4 Principal or Elementary substances; and thereupon inferred, that the Contrary Quality, Cold, ought in like manner to have its principal residence in one of the other 3: when, introth, they ought first to have proved, that there was such a thing as an Element of Fire in the Universe; which is more than any Logick

can

can hope, ſince the Sphere of Fire, which they ſuppoſed to poſſeſs all that vaſt ſpace between the convex of the Sphere of Aer, and the concave of that of the Moon, is a meer Chimæra, as we have formerly intimated, and *Helmont* hath clearly commonſtrated (*in cap. de Aere.*) And Secondly we affirm, that as the Higheſt degree of Heat is not juſtly attributary to any one Body more than other, or by way of ſingular eminency (for, the Sphere of Fire failing, what other can be ſubſtituted in the room thereof?) but to ſundry ſpecial Bodies, which are capable of Exciting or Conceiving Heat, in the ſuperlative degree: ſo likewiſe, though we ſhould concede, that there are 3 Principal Bodies in Nature, namely Aer, Water, Earth, in each whereof the Quality of Cold is ſenſibly harboured; yet *is there no one of them, of its own nature more principally Cold than other, or which of it ſelf containeth Cold in the higheſt degree; but ſome ſpecial Bodies there are, compoſed of them, which are capable of Exciting and Conceiving Cold, in an eminent manner.* But, in Generals is no Demonſtration; and therefore we muſt advance to *Particulars*, and verify our Aſſertion, in each of the Three ſuppoſed Elements apart.

For the *Earth*: foraſmuch as our ſenſe certifieth, that it is even Torrified with Heat, in ſome places, and Congealed with Cold in others, according to the temperature of the ambient Aer in divers climats, or as the Aer, being calefied by the Sun, or frigified by froſt, doth variouſly affect it, in it ſuperficial or Exterior parts; and ſo it cannot be diſcerned, that its External parts are endowed with one of theſe oppoſite Qualities more than the other: and ſince we cannot but obſerve, that there are many great and durable ſubterraneous Fires burning in, and many fervid and ſulphlureous Exlations frequently emitted, and more Hot Springs of Mineral Waters perpetually iſſuing from its Interior parts, or bowels; and ſo it is of neceſſity, that vaſt ſeminaries of Igneous Atoms be included in the Entrals thereof: We ſay, conſidering theſe things, we cannot deny, but that the Earth doth contain as many Particles of Heat, or Calorifick Atoms, both without and within, as it doth of ſeeds of Cold, or Frigorifick Atoms, if not more; and upon conſequence, that it cannot be *Primum Frigidum*, as *Plutarch* and all his *Sectators* have dreamt. What then; ſhall we conclude Antithetically, and conceive that the Globe of the Earth is therefore Eſſentially rather Hot, than Cold? Truely, No; becauſe experience demonſtrateth, that the Earth doth belch forth Cold Exhalations, and congealing blaſts, as well as Hot Fumes, and more frequently: witneſs the North-wind, which is ſo cold, that it refrigerates the Aer even in the middſt of Summer, when the rivers are exhauſted by the fervor of the Sun; to which *Elihu*, one of *Jobs* ſorry Comforters, ſeems to have alluded, when He ſaid, That *Cold cometh out of the North, and the Whirlwind out of the South.* All, therefore, we dare determine in this difficult argument (the deciſion whereof doth chiefly depend upon Experiments of vaſt labour and coſts) is only thus much; that the Earth, which is now Hot, now Cold, in its extreme or ſuperficial parts, may, as to its Internal or profound parts, be as reaſonably accounted to contain various ſeminaries of Heat, as of Cold: and that the principal ſeeds of Cold, or ſuch, as chiefly conſiſt of Frigorifick Atoms; do convene into *Halinitre*, and other Concretions of natures retaining thereto. And our Reaſon is, that *Halinitre* is no ſooner diſſolved in Water, than it congealeth the ſame into perfect Ice, and ſtrongly refrigerates all bodies, that it toucheth; inſomuch that we may not only conclude,

conclude, that of all Concretions in Nature, at leaſt that we have diſcovered, none is ſo plentifully fraught with the Atoms, or ſeeds of Cold, as Halinitre; but alſo adventure to anſwer that Problem propoſed to *Job*, *Out of whoſe womb came the Ice, and the Hoary Froſt of heaven, who hath gendred it?* by ſaying, that all our Freezing and extreme Cold winds ſeem to be only copious Exhalations of Halinitre diſſolved in the bowels of the Earth; or conſiſting of ſuch Frigorifick Atoms, as compoſe Halinitre; and this becauſe of the identity of their Effects, for the Tramontane Wind (the coldeſt of all winds, as *Fabricius Paduanus*, in his exquiſite Book *de Ventis*, copiouſly proveth) which the Italians call *Chirocco*, can pretend to no natural Effect, in which Halinitre may not juſtly rival it. Long might we dwell upon this not more rare than delightful ſubject: but, beſides that it deſerves a profeſt Diſquiſition, apart by it ſelf, our ſpeculations are limited, and may not, without indecency, either digreſs from their proper Theme, or tranſgreſs the ſtrict Laws of Method. May it ſuffice, therefore, in præſent, that we have made it juſtifiable to conceive that the Earth containeth many ſuch Particles, or Atoms (whether ſuch as pertain to the Compoſition of Halinitre, or of any other kind whatever) upon the Exſilition of which the body containing them may be ſaid to become Cold, or paſs from Potential to Actual Cold: and upon the inſinuation of which into Aer, Water, Earth, Stones, Wood, Fleſh, or any other terrene Concretion whatever, Cold is introduced into them, and they may be ſaid to be Frigefied, or made Cold.

Secondly, as for *Water*; that the prætext thereof to the prærogative of Eſſential Frigidity is alſo fraudulent, and inconſiſtent with the *Magna Charta* of right Reaſon, may be diſcovered from theſe conſiderations. 1. When Water is frozen, the Ice always begins in it ſuperfice, or upper parts, where the Aer immediately toucheth it: but, if it were Cold of its own Nature, as is generally præſumed, upon the auctority of *Ariſtotle*, the Ice ought to begin in parts fartheſt ſituate from the Aer, that is in the middle, or bottom, rather than at the top; at leaſt, it would not be more ſlowly conglaciated in the middle and bottom, than at the top. (2.) In all Froſts, the Cold of Water is encreaſed; which could not be, if it were the principal ſeat of Cold. For, how could the Aer which according to the vulgar ſuppoſition, that Water is the ſubject of inhæſion to extreme Cold, if leſs cold, infuſe into water a greater cold, than what it had before of its owne? or, how could Nitre, diſſolved in water, ſo much augment the Cold thereof, as to convert it into Ice, even in the heat of ſummer, or by the fires ſide; as is experimented in Artificial conglaciations: if Nitre were not endowed with greater cold than Water? (3.) If Water be formally ingravidated with the ſeeds of Cold; why is not the ſea, why are not all Rivers, nay, all Lakes and ſtanding Pools (in which the excuſe of continual motion is prævented) conſtantly congealed, and bound up in ribbs of Ice? Whence comes it, that Water doth conſtantly remain Fluid, unleſs in great froſts only, when the Atoms of Cold, wafted on the wings of the North-wind, and plentifully ſtrawed on the waters, doe inſinuate themſelves among its particles, and introduce a Rigidity upon them? Certainly, it is not conform to the Laws of Nature, that any Body, much leſs ſo eminent and uſeful a one as Water, ſhould for the moſt part remain alienated from its owne native conſtitution, and be reduced to it again only at ſome times, after long intervals, and then only for a day or two. (4.) Were Cold

Cold eſſentially competent to Water, it could not ſo eaſily, as is obſerved, admit the Contrary Quality, Heat, nor in ſo high a degree, without the deſtruction of its primitive form. For, no ſubject can be changed from the Extreme of one Quality inhærent, to the extreme of a contrary, without the total alteration of that Contexture of its particles, upon which the inhærent quality depended; which done, it remains no longer the ſame: but Water ſtill remains the ſame, *i. e.* a Humid Fluid ſubſtance, both at the time of, and after its Calefaction by fire, as before. And, therefore, that common ſaying, that *Water heated doth reduce it ſelf to its native Cold*, though it be tollerable in the mouth of the people; yet He that would ſpeak as a Philoſopher, ought to change it into this, that *Water, after calefaction, returns to its primitive ſtate of Indifferency to either Heat, or Cold:* for, though after its remove from the fire, it gradually loſeth the Heat acquired from thence, the Igneous Atoms ſpontaneouſly aſcending and abandoning it one after another; yet would it never reduce it ſelf to the leaſt degree of cold, but is *reduced* to cold by Atoms of Cold from the circumſtant Aer immitted into its pores. What then; ſhall we hence conclude, that Water is Eſſentially *Hot?* Neither; becauſe then it could not ſo eaſily admit, nor ſo long retain the Contrary Quality, Cold, for Hot ſprings are never congelated. Wherein therefore can we acquieſce? Truly, only in this determination, that *Water is Eſſentially Moiſt, and Fluid: but neither Hot, nor Cold, unleſs by Accident, or Acquiſition, i.e.* it is made Hot, upon the introduction of Calorifick, and Cold, upon the introduction of Frigorifick Atoms; contrary to the tenent of *Empedocles*, and *Ariſtotle*.

Laſtly, as for the *Aer*: inſomuch as it is ſometimes Hot, ſometimes Cold, according to the temperature of the Climate, ſeaſon of the year, præſence or abſence of the Sun, and diverſity of Winds: we can have no warrant from reaſon, to conceive it to be the natural Mother of Cold, more than of Heat; but rather that it is indifferently comparated to admit either Quality, according to divers Imprǣgnation. Whoever, therefore, ſhall argue, that becauſe in the Dogg daies, when the perpendicular rayes of the Sun parch up the languiſhing inhabitants of the Earth in ſome poſitions of its ſphere, if the North-wind ariſe, it immediately mitigates the fervor of the Aer, and brings a cool relief upon its wings; therefore the Aer is Naturally Cold: may as juſtly infer, that the Aer is Naturally Hot; becauſe, in the dead of Winter, when the face of the Earth becomes hoary and rigid with froſt, if the South-wind blowe, it ſoon mitigates the frigidity of the Aer, and diſſolves thoſe fetters of Ice, wherewith all things were bound up. Wherefore, it is beſt for us to Conclude, that the *Eſſential Quality* of the Aer, is *Fluidity*; but as for *Heat* and *Cold*, they are Qualities meerly *Accidental* or *Adventitious* thereto; or, that it is made Hot, or Cold, upon the commixture of Calorifick, or Frigorifick Atoms. So that where the Aer is conſtantly imprǣgnate with Atoms of Heat, as under the Torrid Zone, there is it conſtantly Hot, or Warme at leaſt: where it is Alternately perfuſed with Calorifick and Frigorifick Atoms, as under the Temperate Zones; there is it Alternately Hot and Cold: and where it is conſtantly pervaded by Frigorifick Atoms, as under the North Pole; there is it conſtantly Cold.

Art. 7. But to ſome *Special* Concretions, for the moſt part, conſiſting of *Frigorifick* Atoms.

To put a period, therefore, to this Diſpute; ſeeing the Quality of *Cold* is not Eſſentially inhærent in Earth, Water, or Aer, the Three Principal Bodies

Bodies of Nature; where shall we investigate its *Genuine Matrix*; or proper *subject of inhæsion*? Certainly, in the nature of some *Special Bodies*, or a particular species of *Atoms* (of which sort are those whereof Salnitre is for the most part composed) which being introduced into Earth, Water, Aer, or any other mixt Bodie, imprægnate them with cold.

Art. 8. *Water*, the chief Antagonist to Fire; not in respect of its Accidental Frigidity, but *Essential Humidity*: and that the *Aer* hath a juster title to the Principality of Cold, than either Water, or Earth.

But, haply, you may say, that though this be true, yet doth it not totally solve the doubt; since it is yet demandable, *Whether any one, and which of those Three Elements is highly Opposite to the Fourth*, viz. *Fire?* We Answer, that forasmuch as that Bodie is to be accounted the most Opposite to Fire, which most destroyes it: therefore is *Water* the chief Antagonist to Fire, because it sooneſt Extinguisheth it. Nevertheless there is no necessity, that therefore Water must be Cold in as high a degree, as Fire is Hot: for, Water doth not extinguish Fire, as it is Cold (since boyling water doth as soon put out fire, as Cold) but as it is *Humid*, i.e. *as it enters the pores of the enflamed body, and hinders the Motion and Diffusion of the Atoms of Fire.* Which may be confirmed from hence (1.) That Oyle, which no man conceives to be Cold, if poured on in great quantity, doth also extinguish fire, by suffocation, which is nothing but a hindering the Motion of the igneous Atoms: (2.) That in case the Atoms of Fire issue from the accensed matter, with such pernicity and vehemence, and reciprocal arietations, and in such swarms, as that they repel the water affused, and permit it not to enter the pores of the fewel (as constantly happens in Wild-fire, where the ingredients are Unctuous, and consist of very tenacious particles.) in that case, Water is so far from extinguishing the flame, that it makes it more impetuous and raging. However, we shall acknowledg thus much, that if the Principality of Cold must be adscribed to one of the Three vulgar Elements; the *Aer* doubtless, hath the best title thereunto: because, being the most Lax and Porous bodie of the Three it doth most easily admit, and most plentifully harbour the seeds of Cold; and being also subtile and Fluid, it doth most easily immit, or carry them along with it self into the pores of other bodies, and so not only Infrigidate, but some times Congeal, and Conglaciate them; in case they be of such Contextures and such particles, as are susceptible of Congelation and Conglaciation.

Art. 9. PROBLEM: Why the breath of a man doth *Warme*, when expired with the mouth wide open; & *Cool*, when efflated with the mouth contracted.

The Fable of the *Satyr* and *Wayfering man*, who blew hot and cold, though in the mouth of every School-boy, is yet scarce understood by their Masters; nay, the greatest Philosophers have found the reason of that Contrariety of Effects from one and the same Cause, to be highly problematical. Wherefore since we are fallen upon the cause of the Frigidity in the Aer; and the Frigidity of our Breath doth materially depend thereon: opportunity invites Us, to solve that Problem, which though both *Aristotle* (*sect* 3. *prob.* 7. & *Anaximenes* (*apud Plutarch. de frigore primigenio*) have strongly attempted; yet have they left it to the conquest of *Epicurus* principles: *viz. Why doth the breath of a man warme, when efflated with the mouth wide open; and cool, when efflated with the mouth contracted?* To omit the opinions of others, therefore, we conceive the cause hereof to be only this; that albeit the Breath doth consist of aer, for the most part fraught with Calorifick Atoms, emitted from the lungs and vital organs, yet hath it many Frigorifick ones also interspersed among its particles: which being of greater bulk, than the Calorifick, and so capable of a stronger impuls, are by the force of efflation transmitted to greatter distance from the mouth; because, the Calorifick Atoms commixt with

the breath, in regard of their exility, are no sooner dischaged from the mouth, than they instantly disperse in round. Wence it comes, that if the breath be expired in a large stream, or with the mouth wide open; because the circuit of the stream of breath is large, and so the Hot Atoms emitted are not so soon dispersed: therefore doth the stream feel warme to the hand objected there, and so much the more warme, by how much neerer the hand is held to the mouth; the Calorifick Atoms being less and less Dissipated in each degree of remove. But, in case the breath be emitted with contracted lipps; because then the compass of the stream is small, and the force of Efflation greater: therefore are the Calorifick Atoms soon Disgregated, and the Frigorifick only ramain commixt with the Aer, which affects the objected hand with Cold; and by how much farther (in the limits of the power of Efflation) the hand is held from the mouth, by so much colder doth the breath appear, and *è contra.* That Calorifick Atoms are subject to more and more Dispersion, as the stream of a Fluid substance, to which they are commixt, is greater and greater in circuit, may be confirmed from hence; that if we poure hot Water, from on high, in ftosty weather, we shall observe a fume to issue and ascend from the stream all along, and that so much the more plentifully, by how much greater the stream is. Thus we use to cool Burnt wine, or Broth, by frequent refunding it from vessel to vessel, or infunding it into broad and shallow vessels; that so the Atoms of Heat may be the sooner dispersed: for, by how much larger the superfice of the liquor is made, by so much more of liberty for Exsilition is given to the Atoms of Heat contained therein, and as much of Insinuation to the Atoms of Cold in company with the circumstant Aer. Thus also we cool our faces in the heat of Summer, with fanning the aer towards us: the Hot Atoms being thereby dissipated, and the Cold impelled deeper into the pores of the skin: which also is the reason, why all Winds appear so much the Colder, by how much stronger they blowe; as *De's Cartes* hath well observed in these words: *Ventus vehementior majoris frigiditatis perceptionem, quàm aer tranquillus, in corpore nostro excitat; quod aer quietus tantùm exteriorem nostram cutim, quæ interioribus nostris carnibus frigidior est, contingat: ventus verò, vehementiùs in corpus nostrum actus, etiam in penetralia ejus adigatur, cumque illa sint cute calidiora, id circo etiam majorem frigiditatem ab ejus contactu percipiunt.*

Art. 10. Three CONSECTARIES from the premises.

In our precedent Article, touching the necessary assignatin of a Tetrahedical Figure to the Atoms of Cold, we remember, we said; that in respect of their several sides, or plane faces, they were most apt to Compinge, or bind in the particles of all Concretions, into which they are intromitted; and from thence we shal take the hint of inferring Three noble CONSECTARIES.

(1.) That Ice, Snow, Hail, Hoarfrost, and all Congelations, are made meerly by the intromission of Frigorifick Atoms among the particles of Fluid bodies: for, being once insinuated and commixt among them, in sufficient plenty, they alter their fluid and lax consistence into a rigid and compact, *i.e.* they Congeal them.

(2.) That the Horror, or Trembling sometimes observed in the members of Animals; as also that Rigor, or Shaking, in the beginning of most putrid Fevers, and generally when the Fits of Intermittent fevers invade, are chiefly caused by Frigorifick Atoms. For, when the Spherical Atoms of

of Heat, which ſwarm in and vivifie the bodies of Animals, are not moved *quaquaversùm* in the members with ſuch freedom, velocity, and directneſs excentrically, as they ought; becauſe, meeting and conteſting with thoſe leſs Agile Atoms of Cold, which have entred the body, upon its chilling, their proper motion is thereby impeded: they are ſtrongly repelled, and made to recoyle towards the Central parts of the bodie, in avoydance of their Adverſary, the Cold ones; and in that tumultuous retreat, or introceſſion, they vellicate the fibres of the membranous and nervous parts, and ſo cauſe a kind of vibration or contraction, which if only of the skin, makes that ſymptome, which Phyſicians call a *Horror*; but if of the Muſcles in the Habit of the bodie, makes that more vehement Concuſſion, which they call a *Rigor*. Either of which doth ſo long endure, as till the Atoms of Heat, being more ſtrong by Concentration and Union, have re-encountered and expelled them. That it is of the Nature of Hot Atoms, when invaded by a greater number of Cold ones, to recoyle from them, and concentre themſelves in the middle of the body, that contains them; is demonſtrable from the Experiment of Frozen Wines: wherein the ſpirits concentre, and preſerve themſelves free from Congelation in the middle of the frozen Phlegm, ſo that they may be ſeen to remain fluid and of the colour of an Amethyſt: as *Helmont* hath well declared, in his *Hiſtory of the Nativity of Tartar in Wines*.

(3.) That the Death of all Animals, is cauſed immediately by the Atoms of Cold; which inſinuating themſelves in great ſwarms into the body, and not expelled again from thence by the overpowered Atoms of Heat; they wholly impede and ſuppreſs thoſe motions of them, wherein Vitality conſiſteth: So that the Calorifick ones being no longer able to calefy the principal ſeat of life, the Vital flame is ſoon extinguiſhed, and the whole Body reſigned to the tyranny of Cold. Which is therefore well accounted to be the grand and profeſt Enemy of Life.

CHAP. XIII.

OF

Fluidity, Stability, Humidity, Siccity.

SECT. I.

Art. 1. Why *Fluidity* and *Firmness* are here considered before *Humidity* and *Siccity*.

HEre our very Method must be somewhat Paradoxical, and the Genealogy we shall afford of those Two vulgarly accounted Passive Qualities, *Humidity* and *Siccity*, very much different from that universally embraced in the Schools. For, should we tread in the steps of *Aristotle*, as most, who have travelled in this subject, have constantly done; we must have subnected our Disquisition into the Nature and Origine of Moisture and Dryness, immediately to that of Heat and Cold, as the other pair of First Elemental Qualities, and *è diametro* opposite to them. But, having observed, that those 2 Terms, *Moist* and *Dry*, are not, according to the severe and præcise Dialect of truth, rightly accommodable to all those things, which are genuinely imported by those Greek Words, ὑγρὸν and ξηρὸν, according to the definions of *Aristotle*; and consequently that we could not avoid the danger of losing ourselves in a perpetual *Æquivocation* of Terms, unless we committed our thoughts wholly to the conduct of Nature Herself, progressing from the more to the less General Qualities, and at each step explicating their distinct dependencies: we, thereupon inferred, that we ought to præmise the Consideration of *Fluidity* and *Firmness*, which are more General, to that of *Humidity* and *Siccity*, as less General Qualities, and which seem to be one degree more removed from Catholick Principles.

Art. 2. The Latin Terms, *Humidum* and *Siccum*, too narrow to comprehend the full sense of *Aristotle*, ὑγρὸν καὶ ξηρὸν.

That those 2 Terms so frequent in the mouth of *Aristotle*, ὑγρὸν καὶ ξηρὸν, are more ample in signification, than *Humidum* and *Siccum*, by which His Latin Interpreters and Commentators commonly explicate them; is manifest even from hence, that under the word ὑγρὸν is comprehended not only, in General, whatever is ῥυτὸν, *Fluid* and *Liquid*, but

but alſo, in ſpecial, that matter or body, whereby a thing is moiſtned, when immerſed into, or perfuſed with the ſame: and likewiſe, under the contrary term ξηρὸν, is comprehended as well, in General, whatever is πεπηγὸς, *Compact* or *Firm* and *Solid*, as in ſpecial, that matter or body, which being applyed to a thing, is not capable of Humectating or Madefying the ſame, and which is therefore called alſo κεᾶυρον, *Aridum*. Now, this duely perpended doth at firſt ſight deteſt the Æquivocation of the Latin Terms, and direct us to this præciſe determination; that whatever is *Fluid*, is not *Humid*; nor whatever is *Dry*, *Compact* or Firme; but that a *Humid* body properly is that, whereby another body, being perfuſed, is moiſtned [βρέχεται] or madefied [διαίνεται]: and, on the contrary, that a Dry or Arid body is that, which is not capable of Humectating, or madefying another body, to which it is applied.

Art. 3. *Ariſtotles* Definition of a *Humid* ſubſtance, not præciſe enough; but, in common alſo to a *Fluid*; and his Definition of a *Dry*, accommodable to a *Firme*.

Again, foraſmuch as *Ariſtotle* poſitively defines τὸ ὑγρὸν, *id quod facile, terminum admittens, proprio tamen non terminatur*, that which being deſtitute of ſelf-termination, is yet eaſily terminated by another ſubſtance; tis evident, that this His Definition is competent not only to a *Humid* thing, in ſpecial, but alſo to a *Fluid*, in General: ſuch as are not only Water, Oyle, every Liquor, yea and Metal or other Concretion, actually fuſed or melted; but alſo the Aer, Flame, Smoke, Duſt, and whatever is of ſuch a nature, as that being admitted into any veſſel or other continent of whatever figure; or however terminated in it ſuperfice, doth eaſily accomodate it ſelf thereunto, put on the ſame figure, and confeſs termination by the ſame limits or boundaries; and this, becauſe it cannot terminate it ſelf, as being naturally comparated only to Diffuſion. On the other ſide, ſince He defines τὸ ξηρὸν, *quod facile terminatum proprio termino, terminatur ægre alieno*; to be that which is eaſily terminated by its owne ſuperfice, and hardly terminated by another; it is alſo manifeſt, that this Definition is not peculiar only to a *Dry* or *Arid* ſubſtance, but in common alſo to a *Firme* or *Solid* one: ſuch as not only Earth, Wood, Stones, &c. but alſo Ice, Metal unmolten, Pitch, Reſine, Wax, and the like Concreted juices, and (in a word) all bodies, which have their parts ſo conſiſtent and mutually cohærent, as that they are not naturally comparated to Diffuſion, but conſerve themſelves in their own ſuperfice, and require compreſſion, dilatation, ſection, detrition, or ſome other violent means, to accommodate them to termination, by the ſuperfice of another body. And, certainly, if what is præciſely ſignified by the Terme ὑγρὸν, were no more than what is meant by the Latin ſubſtitute thereof, *Humidum*: then might the Aer be juſtly ſaid to be Humid, which is ſo far in its owne nature from being endowed with the faculty of Humectating bodies, that its genuine virtue is to exſiccate all things ſuſpended therein; nay even Fire it ſelf might be allowed the ſame Attribute, together with Smoke, Duſt, and the like Fluid ſubſtances, which exſiccate all bodies perfuſed with moiſture. On the advers part, if what is præciſely intended by the Terme ξηρὸν, were fully expreſſible by the Latin, *Siccum*, or *Aridum*; then, doubtleſs, might Wax, Reſine, and all Concreted juices be accounted actually Dry, nay Ice it ſelf, which is only Liquor congealed, could not be excluded the Categorie of Arid ſubſtances. Theſe Conſiderations premiſed, though we might here enquire, Whether *Ariſtotle* ſpake like Himſelf, when He confined Fluidity (and that according to his owne definition) to only 2 Elements, Water and Aer; when yet the Element of Fire, which He placed above

above the Aereal region, muſt be tranſcendently Fluid(elſe how could it be ſo eaſily terminated by the Concave of the Lunar Sphere, on one part, and the Convex of the Aereal, on the other?) And whether His Antitheſis or Counter aſſertion, *viz.* that the 2 Firme Elements are Fire and Earth, be not a downright Abſurdity: yet ſhall we not inſiſt upon the detection of either of thoſe two Errors, becauſe they are obvious to every mans notice; but only Conclude, that though every Humid body be Fluid, and every Arid or Dry body be Firm; yet will not the Converſion hold, ſince every Fluid is not Humid, nor every Firme, Dry; and upon natural conſequence, that Humidity is a ſpecies of Fluidity, and Siccity a Species of Firmity; and alſo that it is our duety to ſpeculate the Reaſons of each accordingly beginning at the Generals.

Art. 4. *Fluidity* defined.

FLUIDITY we conceive to be a Quality, ariſing meerly from hence; that the Atoms, or inſenſible particles, of which a fluid Concretion doth conſiſt, are ſmooth in ſuperfice, and reciprocally contiguous in ſome points, though diſſociate or incontiguous in others; ſo that many inane ſpaces (ſmaller and greater according to the ſeveral magnitudes of the particles, which intercept them) being interſperſed among them, they are, upon the motion of the maſs or body, which they compoſe, moſt eaſily moveable, rowling one upon another, and in a continued fluor, or ſtream diffuſing themſelves, till they are arreſted by ſome firm body, to whoſe ſuperfice they exactly accommodate themſelves.

Art. 5. Wherein the *Formal Reaſon* thereof doth conſiſt.

That the Eſſence of Fluidity doth conſiſt only in theſe Two conditions, the ſmoothneſs of inſenſible particles, and interruption of ſmall inane ſpaces among them, where their extrems are incontiguous; may be even ſenſibly demonſtrated in an heap or meaſure of *Corne.* Which is apt for Diffuſion, or Fluid, only becauſe the Grains, of which it doth conſiſt, are ſuperficially ſmooth and hard, and have myriads of inane ſpaces intercepted among them, by reaſon of the incontiguities of their extrems, in various points: ſo that, whenever the heap is moved, or effuſed from one veſſel into another, the Grains mutually rowling each upon other, diffuſe themſelves in one continued ſtream, and immediately upon their reception into the concave of the veſſel, the Aggregate or maſs of them becomes exactly accommodate to the figure, or internal ſuperfice of the ſame. And, forasmuch as the different magnitudes of compoſing particles, do not neceſſitate a difference of formal qualities; but only variety of Figures, contexture and motion: well may we conceive the ſame reaſons to eſſence the Fluidity of Water alſo; becauſe betwixt an heap of Corne, and an heap or maſs of Water, the Difference is only this, that the Grains, which compoſe the one, are of ſenſible magnitude, and ſo have ſenſible empty ſpaces interpoſed among them; but the Granules, or particles, which compoſe the other, are of inſenſible magnitude, or incomparably more exile, and ſo have the inane ſpaces intercepted among them, incomparably leſs. For, that Water doth conſiſt of ſmall Grains, or ſmooth particles, is conſpicuous even from hence; that Water is capable of converſion into Fume, or Vapour, only by Rarefaction, and Fume again reducible into Water, meerly by Condenſation; and the reaſon why Fume becoms viſible, is only this, that the leaſt viſible part of fume is a Collection or Aſſembly of many thouſand of thoſe ſingly-inviſible particles, which conſtitute the Water, from whence the fume aſcends; as may be aſcertained from hence, that to the com-

compoſition of one ſingle drop of Water, many myriads of myriads of inſenſible particles muſt be convened and united. So that Water contained in a Caldron, ſet on the fire and ſeething, doth differ from the Fume exhaled from it, only in this reſpect; that the one is Water Condenſed, the other Rarified: or, that Water is made Fume, when its particles are violently diſſociated, and the aer variouſly intercepted among them; and Fume is returned to Water, when the ſame particles are reduced to their natural cloſe order, and the intercepted aer again excluded. Again, that the Fluidity of Water depends on the ſame Cauſe (proportionately) as that of an heap of Corne, may, according to the Lawe of Similitude, be juſtified by the parallel capacity of Water to the ſame Effects, *viz.* Diffuſion, Diviſion, and Accommodation to the figure of the Recipient, or Terminant: For, the reſult hereof is, that it hath no Continuity or mutual Cohærence of its particles, which ſhould hinder their eaſy Diſſociation. Nor is it a valid Argument to the contrary, that Water appears to be a *Continued* body, but an heap of Corne, a Diſcontinued; for, that is only according to *Apparence*, cauſed from hence, that by how much ſmaller the component particles of a Concretion are, by ſo much ſmaller muſt the inane ſpaces be, which are intercepted among them, where they are incontiguous, and upon conſequence, ſo much the leſs interrupted, or more continued muſt the maſs or Aggregate appear: as may be moſt familiarly underſtood, if we compare an heap of Corne, with one of the fineſt *Callis* ſand; that with an heap of the moſt volatile or impalpable Powder, that the Chymiſt or Apothecary can make; and ſo gradually leſs and leſs in the dimenſions of Granules, till we arrive at the ſmalleſt imaginable. So that we cannot wonder, that the ſubſtance of Water ſhould be apprehended by the dull ſenſe, as wholly Continued, though really it be only leſs interrupted than an heap of ſand: when the Grains, whereof Water is amaſſed, are incomparably ſmaller, than thoſe of the fineſt ſand, and intercept among them inane ſpaces incomparably ſmaller ſuch as are by many degrees belowe the diſcernment of the acuteſt ſight, though advantaged by the beſt Microſcope.

Art. 6. The ſame farther illuſtrated, by the *two-fold* Fluidity of *Metals*; and the peculiar *reaſon* of each.

If this Argument reach not the height either of the Difficulty it ſelf, or your Expectation and Cnrioſity concerning it; be pleaſed to imp the Wings of it with the feathers of another, of the ſame importance, but more perſpicuity. It is well known, eſpecially to Chymiſts and Refiners, that every metall is capable of a *twofold Fluidity*: *one*, in the forme of an impalpable or volatile *Powder*; the other, of a *Liquor*, whoſe fluor is continued, according to the judgement of ſenſe. For, when a Metal is Calcined by Præcipitation, *i.e.* by Corroſive and Mercurial Waters, ſpecifically appropriate to its nature; being thereby reduced into ſmall Grains, it becomes Fluid, after the manner of ſand, and therefore may as conveniently be uſed in Hour-glaſſes, for Chronometry, or the meaſure of time: but, becauſe each of thoſe viſible Grains is made up of millions of other more exile and inviſible Granules or particles, which are the component principles or matter of the Metal; hence it is, that if we put them all together in a Crucible, and melt them in a reverberatory fire, whoſe igneous Atoms invade, penetrate and ſubdivide each Granule into the ſmalleſt particles (to which the Corroſive Virtue of the *Aqua fortis* could not extend) then will the whole maſs put on another kind of Fluidity, ſuch as that of Water, Oyle, and all other Liquors. Now, the *Reaſon* of the *Former* Fluidity is manifeſtly the ſame with that of *Corne* and *Sand*, newly explicated:

explicated: and that of the *Latter*, the ſame as of *Water*, *i.e.* the Granules of the Calcined powder, being diſſolved into others of dimenſions incomparably ſmaller, do intercept among themſelves, or betwixt their ſuperficies, where thoſe are incontiguous, innumerable multitudes of Inane ſpaces, but thoſe incomparably leſs than before their ultimate ſubtiliation; and conſequently (as hath been ſaid) make the Metal diſſolved to be deprehended by the ſenſe, as one entire and continued ſubſtance. To Conclude, therefore; we can diſcover no Reaſon againſt us, of bulk ſufficient to obſtruct the current of our Conception, that the Fluidity of *Fire*, *Flame*, *Aer*, and all *Liquid* ſubſtances whatever, cannot well be deduced from any other Cauſe, but what we have here aſſigned to Water and Metals diſſolved: eſpecially when we conſider, that it is equally conſentaneous to conceive, that every other Fluid or Liquid body is compoſed alſo of certain ſpecially-configurate Granules, or imperceptible particles; which being only contiguous in ſome points of their ſuperficies, not reciprocally Cohærent, cannot but intercept various inane ſpaces betwixt them; and be therefore eaſily emovable, diſſociable, externally terminable, and capable of making the body apparently Continuate, as Water it ſelf.

Art. 7. Firmneſs defined:

And, as for the other General Quality, FIRMNESS, or STABILITY; ſince Contraries muſt have Contrary Cauſes, and that the ſolidity of Atoms is the fundament of all ſolidity and firmneſs in Concretions: well may we underſtand it to be radicated in this, that the inſenſible particles, of which a Firme Concretion is compoſed (whether they be of one or diverſe ſorts, *i.e.* ſimilar or diſſimilar in magnitude and figure) do ſo reciprocally compreſs and adhære unto each other, as that being uncapable of rowling upon each others ſuperfice, both in reſpect of the ineptitude of their figures thereunto, and the want of competent inane ſpaces among them, they generally become uncapable (without extream violence) of Emotion, Diſſociation, Diffuſion, and ſo of Termination by any other ſuperfice, but what themſelves conſtitute.

Art. 8. And derived from either of 3 *Cauſes.*

If it be farther Enquired, Whence this reciprocal Compreſſion, Indiſſociability, and Immobility of inſenſible particles in a Firme, Concretion doth immediately proceed; we can derive it from Three ſufficient Cauſes. (1.) *The many ſmall* [*Hamuli, Uncinulivè*] *Hooks* or *Clawes* by which Atoms of unequal ſuperficies are adapted to implicate each other, by mutual cohærence: and that ſo cloſely, as that all Inanity is excluded from betwixt their commiſſures or joynings; and this is the principal and moſt frequent Cauſe of ſtability. (2.) *The Introduction and preſſure of Extraneous Atoms*, which invading a Concretion, and wedging in both themſelves, and the inteſtine ones together, and that cheifly by obverting their plane ſides or ſuperficies thereunto; cauſe a general Compreſſion and Cohæſion of all the particles of the maſs. And by this way doth froſt congeal Water and all Humid Subſtances; for, ſince the Atoms of Cold are tetrahedical, and thoſe of Water octahedrical, as is moſt reaſonably conjecturable; thoſe of Cold inſinuating themſelves into the ſubſtance of Water, by obverſion of their plane ſides to them, they arreſt the rowling particles thereof, and ſo not permitting them to be moved as before, impede their fluidity, and make the whole maſs Rigid and Hard, or Firme. Hither alſo may we moſt congruouſly referr the

the Coagulation of milk, upon the injection of Rennet, Vinegre, juice of Limons, and the like Acid things. For, the Hamous and inviscating Atoms, whereof the Acid is mostly composed, meeting with the Ramous and Grosser particles of the milk, which constitute the Caseous and Butyrous parts thereof; instantly fasten upon them with their hooks, connect them, and so impeding their fluiditie, change their lax and moveable contexture into a close and immoveable or Firme: while the more exile and smooth particles of the milk, whereof the serum or whey is composed, escape those Entanglings and conserve their native Fluidity. This may be confirmed from hence; that whenever the Cheese, or Butter made of the Coagulation, is held to the fire, they recover their former Fluidity: because the tenacious particles of the Acid are disentangled and interrupted by the sphærical and superlatively agile Atoms of fire. (3.) *The Exclusion of introduced Atoms*, such as by their exility, roundness and motion, did, during their admistion, interturbe the mutual Cohæsion and Quiet of domestique ones, which compose a Concretion. Thus, in the decalescence of melted metals, and Glass, when the Atoms of fire, which had dissociated the particles thereof and made them Fluid, do abandon the metal, and so cease to agitate and dissociate the particles thereof: then do the domestique Atoms returne to a closer order, mutually implicate each other, and so make the whole mass Compact and Firme, as before. Thus also when the Atoms of Water, Wine, or any other dissolvent, which had insinuated into the body of Salt, Alume, Nitre, or other Concretion retaining to the same tribe; and dissolving the continuity of its particles, metamorphosed it from a solid into a fluid body, so that the sight apprehends it to be one simple and uniforme substance with the Liquor: we say, when these dissociating Atoms are evaporated by heat, the particles of the Salt instantly fall together again, become readunated, and so make up the mass compact and solid, as before, such as no man, but an eye-witness of the Experiment, could persuade himself to have been so lately diffused, concorporated, and lost in the fluid body of Water.

SECT. II.

Art. I. Humidity defined.

BY the light of the Præmises, it appears a most perspicuous truth, that HUMIDITY is only a certain Species of Fluidity. For, whoever would frame to himself a proper and adæquate Notion of an *Humor*, or *Humid* substance; must conceive it to be *such a Fluid or Fluxile body, which being induced upon, or applied unto any thing, that is Compact, doth adhare to the same* (per minimas particulas) *and madify or Humectate so much thereof as it toucheth.* Such, therefore, is Water, such is Wine, such is Oyle, such are all those Liquors, which no sooner touch any body not Fluid, but either they leave many of their particles adhærent only to the superfice thereof (and this, because the most seemingly polite superfice is full of Eminences and Cavities, as we have frequently asserted) and so moisten it; or, penetrating through the whole contexture thereof, totally Humectate or wett the same. But, such is not Aer, such is not any Metal fused, such is not Quick-silver, nor any of those

Fluors, which though they be applied unto, and ſubingreſs into the pores of a Compact body, doe yet leave none of their particles adhærent to either the ſuperficial or internal parts thereof; but, without diminution of their own quantity, run off clearly, and ſo leave the touched or pervaded body, unmadified, or unhumectate, as they found it.

Art. 2. *Siccity* defined.

On the other ſide, it is likewiſe manifeſt, that SICCITY or ARIDITY, is only a certain ſpecies of Firmneſs, or ſtability: becauſe a Dry or Arid ſubſtance is conceived to be Firm or Compact, only inſomuch as it is void of all moiſture. Of this ſort, according to vulgar conception, may we account all Stones, Sand, Aſhes, all Metals, and whatever is of ſo firme a conſtitution, as contains nothing of Humidity, either in it ſuperfice, or entrals, which can be extracted from it, or, if extracted, is not capable of moiſtning any other body: but, not Plants nor Animals, nor Minerals, nor any other Concretion; which, though apparently dry to the ſenſe, doth yet contain ſome moiſture within it, and ſuch as being educed, is capable of humectating another body.

Art. 3. Siccity, rather *Comparative*, than Abſolute.

We ſay, *According to Vulgar Conception*; becauſe, not *Abſolutely*: for, though Siccity be oppoſed to Humidity, not as an Habit, to which any Act can be juſtly attributed, but as a meer Privation (for, to be Dry, is nothing elſe but to want moiſture) yet, becauſe a Moiſtned body may contain more or leſs of Humidity, therefore may it be ſaid to be more or leſs Dry Comparatively, and a body that is imbued with leſs moiſture, be ſaid to be dryer than one imbued with more. Thus Green Wood, or ſuch as hath imbibed extraneous moiſture, is commonly ſaid to grow more and more dry by degrees, as it is more and more Dehumectated; and then at length to be perfectly dry, when all the Aqueous moiſture, as well natural as imbibed, is conſumed, though then alſo it contain a certain unctuous moiſture, which Philoſophers call the *Humidum Primigenium*: but, this only Comparatively, or in reſpect to its former ſtate, when it was imbued with a greater proportion of Humidity.

Art. 4. All moiſture either *Aqueous* or *Oleaginous*.

For the illuſtration of this, we are to obſerve, that there are *Two* ſorts of Moiſture, wherewith compact bodies are uſually humectated; the one, *Aqueous* and *Lean*; the other, *Oleaginous* and *Fat*. The *First* is eaſily diſſoluble and evaporable by heat, but not inflammable: the *other*, though it eaſily admit heat, and is as eaſily inflammable, in regard of the many igneous Atoms contained therein; is not eaſily exſoluble, nor attenuable into fume, in regard of the Tenacious cohærence of its particles. To the Firſt kind may be referred that moiſture in Concretions, which Chymiſts extracting, call the *Mercury* of Vegetables: becauſe, though it moiſtens as Water, and is as incapable of inflammation, yet is it much more volatile or evaporable. And, to either or both ſorts, though in a diverſe reſpect belongs that, which they call *Aqua Vitæ*, or the ſpirits of a Vegetable, ſuch as ſpirit of Wine: becauſe though it doth moiſten as Water, yet is it far more eaſily diſſoluble and evaporable by heat, and as inflammable as oyle. And thus much we learn in the School of Senſe, that ſuch bodies as are humectate with the Aqueous and Lean moiſture, are eaſily capable of Exſiccation: but ſuch as are humectate with the Unctuous and Fat, very hardly: Why? becauſe the Atoms, of which the

the Aqueous doth consist, are more lævigated or smooth in their superfice, and so having no hooks, or clawes, whereby to cohære among themselves, or adhære to the concretion, are soon disgregated; but those, which compose the Oleaginous, being entangled as well among themselves, as with the particles of the body, to which they are admixt, by their Hamous angles, are not to be expeded and disengaged, without great and long agitation, and after many unsuccessful attempts of evolution. Thus Wood is sooner reduced to Ashes, than a stone: because that is compacted by much of Aqueous Humidity; this by much of Unctuous. For the same reason is it likewise, that a clodd of Earth, or peice of Cloth, which hath imbibed Water, is far more easily reficcated, than that Earth or Cloth, which hath been dippt in oyle, or melted fat. And this gives us somewhat more than a meer Hint toward the clear Solution of Two PROBLEMS, frequently occurring, but rarely examined.

Art. 5. PROBLEM 1. Why pure water cannot wash out oyle from a Cloth; which yet water, wherein Ashes have been decocted, or soap dissolved, easily doth? Solut.

The one is, *Why pure or simple Water cannot wash out spots of Oyle, or Fat from a Cloth, or silk Garment: which yet Water, wherein Ashes have been boyled, or soap dissolved, easily doth?* For, the *Cause* hereof most probably is this; that though Water of it self cannot penetrate the unctuous body of oyle, nor dissociate its tenaciously cohærent particles, and consequently not incorporate the oyle to it self, so as to carry it off in its fluid arms, when it is expressed or wrung out from the cloth: yet, when it is imprægnated with Salt, such as is abundantly contained in Ashes, and from them extracted in decoction; the salt with the sharp angles and points of its insensible particles, penetrating, pervading, cutting and dividing the oyle, *in minimas particulas*, the Water following the particles of salt at the heels, incorporates the oyle into it self, and so being wrung out from the cloth again, brings the same wholly off together with it self. Which doubtless, was in some part understood by the Inventor of soap; which being compounded of Water, Salt and Oyle most perfectly commixt, is the most general Absterfive for the cleansing of Cloathes polluted with oyle, grease, turpentine, sweat and the like unctuous natures: for, the particles of oyle ambuscadoed in the soap, encountring those oyly or pinguous particles, which adhære to the hairs and filaments of Cloth and stain it, become easily united to them, and bring them off together with themselves, when they are dissolved and set afloat in the Water by the incisive and dissociating particles of the Salt; which also is brought off at the same time by the Water, which serveth only as a common vehicle to all the rest.

Art. 6. PROBLEM 2. Why stains of *Ink* are not to be taken out of cloths, but with some *Acid* Liquor? Solut.

The other, *Why stains of Ink are not Delible, with Water, though decocted to a Lixirium, or Lee, with Ashes, or commixt with soap: but with some Acid juice, such as of Limons, Oranges, Crabbs, Vinegre, &c.* For, the Reason hereof seems to be only this; that the Vitriol, or Coperose, which strikes the black in the Decoction of Galls, Sumach, or other Adstringent Ingredients, being Acid, and so consisting of particles congenerous in figure and other proprieties to those which constitute the Acid juices: whenever the spot of Ink is throughly moystned with an acid liquor, the vitriol is soon united thereto, and so educed together with it upon expression, the union arising (*propter* ὁμοίωσιν) from the *Similitude* of their two natures. For, there always is the most easy and perfect *union*, where is a *Similitude* of Essences, or formal proprieties;

as is notably experimented in the eduction of Cold from a mans hands or other benummed parts by rubbing them with ſnow; in the evocation of fire by fire; in the extraction of ſome Venoms from the central to the outward parts of the body, by the application of other Venoms to the skin (which is the principal cauſe, why ſome Poyſons are the Antidotes to others); the alliciency and evacuation of Choler by Rhubarb, &c.

Laſtly, in this place, we might pertinently inſiſt upon the Cauſes and Manner of Corroſion and Diſſolution of Metals and other Compact and Firme bodies, by *Aqua Fortis*, *Aqua Regis*, and other Chymical Waters; the Exſolubility of Salt, Alume, Nitre, Vitriol, Sugar and other Salin concreted juices, by Water; the Exhalability or Evaporability of Humid and Humectating ſubſtances, and other uſeful ſpeculations of the like obſcure nature: but, each of theſe deſerves a more exact and prolix Diſquiſition, than the time conſigned to our præſent province will afford; and what we have already ſaid, ſufficiently diſchargerh our debt to the Title of this Chapter.

CHAP.

CHAP. XIV.

Softness, Hardness, Flexility, Tractility, Ductility, &c.

SECT. I.

Art. 1. The *Illation* of the Chapter.

THE two First of this Rank, of Secundarie Qualities HARDNESS and SOFTNESS, being so neer of Extraction and Semblance, that many have confounded them with Firmness and Fluidity, in a General and looser acceptation (for, so *Virgil* gives the Epithete of *Soft* to Water, & *Lucretius* to Aer, Vapors, Clouds, &c.) because a *Firme* bodie, or such whose parts are reciprocally cohærent, and superfice more than only apparently continued, as Wax, may be *Soft*; and on the other side, a *Fluid* body; or such whose particles are not reciprocally cohærent, nor superfice really continued, as sand, may be *Hard*: therefore ought we to begin our examination of the nature of *Hardness* and *Softness*, and their Consequents, *Flexility*, *Tractility*, *Ductility*, *&c.* where that of Firmness and Fluidity ends; that so we may, by explicating their *Cognation*, when mentioned in a *general* sense, manifest their *Differences*, when considered in a *Special* and præcise, and so prevent the otherwise imminent danger of æquivocation.

Art. 2. *Hard* and *Soft*, defined.

To come, therefore, without farther circumambage, to the disquisition of the proper nature of each of these Qualities, according to the method of their production; conforming our conceptions to those of *Aristotle*, who (4. *Meteor.* 4.) defines *Durum* to be, *Quod ex superficie in seipsum non cedit*; and *Molle*, to be *Quod ex superficie in seipsum cedit*; and referring both to the cognizance of the sense of Touching, we understand a HARD body to be such, *whose particles are so firmely coadunated among themselves, and superfice is so continued, as that being prest by the finger, it doth not yeeld thereto, nor hath it superfice at all indented or depressed thereby*; such is a stone; and on the contrary, a SOFT one to be such, *as doth*

doth yield to the pressure of the finger in the superfice, and that by retrocession or giving back of the superficial particles, immediately prest by the finger, versus profundum, *towards it profound or internal*; such as Wax, the Flesh of Animals, Clay, &c.

Art. 3. The Difference betwixt a *Soft* and *Fluid.*

For, the chief Difference betwixt a *Fluid*, and a *Soft* body, accepted in a Philosophical or præcise, not a Poetical or random sense, consisteth only in this; that the *Fluid*, when prest upon, doth yield to the body pressing, not by indentment or incavation of it superfice, *i.e.* the retrocession of it superficial particles, which are immediately urged by the depriment, toward its middle or profound ones, which are farther from it; but by rising upwards in round and equally on all sides, as much as it is depreſt in the superfice: and a *Soft* doth yield to the body pressing, only by retrocession of it superficial inwards toward it central particles, so that they remain during, and sometimes long after the depression, more or less lower than any other part of the superfice. Which being considered, *Aristotles* judgement, that *Softness is incompetent to Water*, must be indisputable: because tis evident to sense, that Water, being depreſt in the superfice doth not recede towards its interior or profound parts, as is the property of all soft things to doe; but riseth up in round equally on all sides of the body pressing, and so keeps it superfice equally and level as before.

Art. 4. *Solidity* of *Atoms*, the Fundament of Hardness and *Inanity*, intercepted among them, the fundament of *Softness*, in all Concretions.

As for the *Fundamental Cause* of *Hardness* observed in Concretions; it must be the chief essential propriety of Atoms *Solidity*: and upon consequence, the *Original* of its Contrary, *Softness* must be *Inanity*. For, among Concretions, every one is more and more Hard, or less and less soft, according as it more and more approacheth to the solidity of an Atom, which knowes nothing of softness: and on the other side, every thing is more and more soft, or less and less hard, according as it more and more approacheth the nature of Inanity, which knowes nothing of Hardness. Not that the Inane space is therefore capable of the Attribute of *Soft*, as if it had a superfice, and such as could recede inwards upon pression: but, that every Concretion is alwayes so much the more soft, *i.e.* the less hard, by how the more it yields in the superfice upon pressure; and this only in respect of the more of Inanity, or the Inane space intercepted among the solid particles, whereof it is composed. It need not be accounted Repetition, that we here resume what we have formerly entrusted to the memory of our Reader; *viz.* that touching the deduction of these two Qualities, Hardness and Softness, the provident Atomist hath wonn the Garland from all other Sects of Philosophers: for, supposing the Catholike materials of Nature to be Atoms, *i. e.* Solid or inflexible and exsoluble Bodies, he is furnished with a most sufficient, nay a necessary Reason, not only for the Hardness or Inflexibility, but also for the Softness or Flexibility of all Concretions; insomuch as it is of the essence of his Hypothesis, that every compound nature derives its Hardness only from the Solidity of its materials, and softness only from the Inane space intercepted among its component particles; in respect whereof each of those particles is moveable, and so the whole Aggregate or mass of them becomes flexible, or devoid of rigidity in all its parts, and consequently yeelding in that part, which is pressed. But, no other Hypothesis excogitable is fruitful enough to afford a satisfactory, nay not so much as a meerly plausible solution of this

this eminent and fundamental Difficulty; for, those who assume the universal matter to be voyd of Hardness, and so infinitely exsoluble, *i.e.* not to be Atoms, though they may, indeed, assign a sufficient reason, why some Concretions are soft; yet shall they ever want one to answer him, who demands, why other Concretions are Hard; because themselves have exempted Atoms, from whose solidity all Hardness ariseth to Concretions.

Art. 5. Hardness and Softness, no Absolute, but meerly *Comparative* Qualities; as adscriptive to Concretions: contrary to *Aristotle.*

And this most easily detecteth the gross and unpardonable incogitancy of *Aristotle*, when He determined the Hardness and Softness of Concretions to be *Absolute* Qualities; for, since Atoms alone are absolutely void of all Softness, and the Inane space alone absolutely void of all Hardness; and all Concretions are made up of Atoms: nothing is more manifest, than that Hardness and Softness, as attributary to Concretions, are Qualities meerly *Comparative*, or more præcisely, that Softness is a Degree of Hardness; and consequently, that there are various Degrees of Hardness, according to which Concretions may be said to be more or less Hard, and such as are hard, in respect of one, may be yet soft in respect of another, that is more hard, or less soft.

Art. 6. *Softness* in *Firme* things; deduced from the same cause, as *Fluidity* in *Fluid* ones.

As for the præcise *Manner*, how the several Degrees of Hardness and Softness result from Atoms and Inanity commixt; we need not much insist thereupon; since the production of each degree may be easily and fully comprehended, from our præcedent explanation of the Causes of Fluidity and Firmness. For, though Softness be observable in bodies endowed with Firmness, or Influxibility; yet because the degrees of Firmness are also various, and proceed from the more or less Arresting or Impeding of Fluidity, and so that the thing consist of Atoms more or less Coarctated, moveable among themselves, and dissociable each from other (from whence alone doth the yeeldingness of it in the superfice arise): therefore is it necessary, that in Firme things the same is the cause of Softness, which in Fluid things is the cause of Fluidity. Nor is the Difference betwixt their productions other than this, that to *Softness*, specially and strictly accepted, are required Atoms somewhat *Hooked*, and so Retentive each of other, as not to be wholly dissociated, or to permit a manifest abruption or breach of continuity, upon pressure: but, to strict Fluidity it is not requisite, that the Atoms be at all Hamous, or reciprocally retentive.

Art. 7. The *General* Reason of the *Mollification* of *Hard*, and *Induration* of *Soft* bodies.

Insomuch, therefore, as there is some certain Compactness (more or less) even in all Soft Concretions; from thence it may be easily inferred, that the *General* reason of the *Mollification* of *Hard* bodies, doth consist in this; that their insensible particles be in some degree dissociated, *i.e.* so separated each from other, in many points, as that more and larger inane spaces be intercepted among them, than while they were closely coadunated: and on the contrary, that the *General* reason of the *Induration* of *Soft* bodies, doth consist only in this; that their insensible particles, before in some degree dissociated, be reduced to a closer order, or higher degree of Compactness, and so most of the inane spaces intercepted, be excluded from among them. To this the doubting *Mersennus* fully subscribes (*in lib. 2. Harmonicor. proposit. ultima*) where deducing the causes of Hardness, Rigidity, and the like qualities from the Atoms of *Democritus* and *Epicurus*, he plainly saith; *Duritiem fieri*

fieri ab Atomis ramosis, quæ suis hamatis implicationibus perexigua spatia relinquunt inania, per quæ nequeant ingredi corpuscula caloris, &c. Nay, such is the urgencie of this truth, that *Aristotle* Himself seems to confess it, in these words: *quæ humoris absentia concrescunt & duruntur, ea liquefacere humor potest; nisi adeo sese (particulæ nimirum) collegerint coierintque, ut minora partibus aquæ foramina sint relicta: id quod fictili accidit, &c.* (4. *Meteorum. cap.*8.) And we need seek no farther than a ball of wool, for the *Exemplification* of both; for, that being so relaxed, as that the hairs touch each other more rarely, or in fewer points, and thereupon more of the ambient Aer be intercepted among them, instantly becomes soft: and then being so compressed, that the hairs touch each other more frequently, or in more points, and the aer be thereupon again excluded from among them, it as soon becomes hard.

Art. 8. The *special* manners of the Mollification of Hard: and Induration of Soft bodies.

But if we wind up our curiosity one note higher, and enquire the *Special Manner* of Mollifying Hard bodies; we shall find it to rest upon either *Heat*, or *Moisture*. Upon *Heat*, when the Atoms of fire, subingressing into the pores of a Hard Concretion doe so commove and exagitate the insensible particles thereof, that they become incontiguous in more points, than before, and so the whole mass being made more lax and rare, upon the interception of many new inane spaces among its particles, puts on a capacity of yeelding to any thing that presseth it, and of receding from it superfice toward its interiors, according to the property of softness. Thus Iron made red hot, is mollefied, and hard Wax liquefied by heat. Upon *Moisture*, when the particles of an Humor so insinuate themselves among the closely cohærent particles of a Hard body, that dissociating them in some measure, they intermix among them, and so (themselves being sufficiently yeelding upon pressure) cause the bodie to become yeelding and recessive from it superfice inwards. Thus Leather is softned by lying in Water, or Oyle; and Clay assumes so much the more of softness, by how much the more of water it hath imbibed.

On the other side, if we pursue the *Induration* of *Soft* bodies up to its *Special* Manner, we shall secure it either in *Cold*, or *Siccity*. In *Cold*, whether we understand it to be a simple expulsion of Calorifick Atoms, lately contained in the bodie; as in the growing hard of Metals after fusion: or the introduction of Frigorifick Atoms into the bodie, naturally void of them; as in the induration of Water into Ice. In *Siccity*, whether we conceive it to be a meer expulsion of the particles of moisture from a Concretion; as when Earth is baked into Bricks: or a superinduction of drie particles upon a moist concretion; as in the composition of Pills, which for the most part consist of Drie Powders and Syrupe, or some other viscid moisture.

Art. 9. PROBLEM. Why Iron is Hardned, by being immersed red-hot into Cold Water; and its SOLUTION.

But here we feel a strong Remora, or *Doubt*; How it comes about, *that Iron made glowing hot, and immediately plunged into cold Water, acquires a greater degree of hardness, than it had before?* And to remove it, we *Answer*; that the particles of the Water subingress into the amplified pores of the Iron, and are not again excluded from thence, though the particles thereof returne to their former close order, and reciprocally implicate each other, as before in candescence; but, remaining imprisoned

imprisoned in the small incontiguities, or inane spaces, which otherwise would have been empty, make the body of the iron somewhat more solid or hard than otherwise it would have been. That this is a sufficient Cause of that Effect; may be warrantably inferred from hence; that if the same seasoned iron be afterwards brought to the fire again, and therein made red hot, so that the contexture of its particles be relaxed, and the particles of Water, which possess the inane spaces betwixt them, be evaporated; there doth it resume its former Softness; and this our Smiths call *Nealing* of Iron.

Art. 10. The *Formal Reasons* of Softness and Hardness.

To steer on, therefore, the same course of Disquisition we have begun; forasmuch as Softness is defined by the *Facility*, and Hardness by the *Difficulty* of bodies *yielding* in the superfice: the only Considerable remaining to our full explanation of the formal Reason of each of these two Qualities, is, *How the yielding of a Soft body in the Superfice is effected*; for, that being once explicated, the rule of Contraries will easily teach us, *Wherein the Resistence of a Hard doth immediately consist.* And this requires no tædious indagation, for from the Præmises it may easily be collected; that a soft body doth then yeild, when its particles immediately pressed in the superfice, do sink down and subingress into the pores immediately beneath them, and then press down the next subjacent particles into pores immediately beneath them; and those likewise press down the next inferior rank of particles into void spaces below them; and those again press down others successively until (the number of pores or void spaces successively in each subingression decreasing) there be no more room to receive the last pressed particles, and then the subingression ceaseth. If this seem not sufficient to make the yeildingness of Soft bodies clearly intelligible; we must remit our Reader to our præcedent Discourse concerning the incapacity of Aer to be Condensed or Compressed, in a Wind-gun, beyond a certain proportion, or determinate rate. Farther, because a soft body cannot be squeezed, unless it rest upon or against something that is hard, at least, less soft than it selfe; so that, though the lower superfice thereof, relying upon the support, is so bounded, that it hath no liberty of space, whether to recede *Versùs profundum*; yet hath it full liberty of space *Versus latera*: therefore comes it to pass, that the subingression of particles into pores, and the Compression of others, is made not only *Versus profundum*, in that part of the soft body, which directly confronteth the hard, whereupon it resteth; but also *Versus latera*, toward the sides, or circumambient. And that after a various manner, according to the various Contextures of soft bodies in the superfice.

Art. 11. The ground of *Aristotles* Distinction betwixt *Formatilia* and *Pressilia*.

For, if the superfice (*i. e.* the outward part) of a soft body, be of a more Compact and tenacious Contexture, than the interior mass or substance; as is the skin of an Animal, compared to the subjacent flesh, and a bladder in respect of the oyle therein contained: in that case, the compression of the particles is, indeed, propagated by succession to some distance as well toward the bottom, as the sides, to which the superior particles being pressed directly downward, and there resisted, deflect; yet not to that distance, as where the superfice is of the same Contexture with the interior mass, as in Wax and Clay, in both which, the Compression, and so the yeilding may be propagated quite thorow,

 or

or from the ſuperior to the inferior ſuperfice, where it immediately reſteth upon the hard body, all the intermediate particles ſtarting toward the ſides, as being preſſed above and reſiſted belowe. And hereupon, doubtleſs, was it that *Ariſtotle* properly called thoſe ſoft bodies, whoſe ſuperfice is either of a weaker, or of the ſame contexture with their internal ſubſtance, πλαστὰ, *Formatilia*; inſomuch as when a Seal or other Solid body doth preſs them, they ſuffer ſuch a Diffraction or Solution of Continuity in their ſuperficial parts, as that the diſſociated particles are not able to reſtore themſelves to their former ſituation and mutual cohæſion, but retain the figure of the body which preſſed them: and, on the contrary, ſuch as have the contexture of their ſuperfice more firm and tenacious than that of their internal maſs, πιεστὰ, *Preſsilia*; inſomuch as upon preſſure they ſuffer not ſo great a Diffraction or Solution of Continuity in their ſuperficial parts, but that they ſtill have ſome mutual cohærence, and ſo are able to reſtore themſelves to their former ſituation, upon the remove of the body that preſſed them.

Art. 12. Two *Axioms*, concerning & illuſtrating the nature of Soſtneſs.

For the illuſtration of this, it is obſervable (1) That to the yielding of every ſoft body, when preſſed, it is neceſſary, that it have *freedom of ſpace on its ſides*: becauſe, if the lateral particles, when preſſed by the intermediate ones, have not room whether to recede, they cannot yield at all; and ſo the Compreſſion muſt be very ſmall. This may moſt ſenſibly be Exemplified in a tube filled with Water; for, if you attempt to compreſs the Water therein contained, with a Rammer ſo exactly adapted to the bore of the tube, as that no ſpaces be left betwixt it and the ſides thereof, whereat the water may riſe upward, you ſhall make but a very ſmall and almoſt inſenſible progreſs therein. (2) *That no ſuperfice of what contexture ſoever, can be depreſſed* verſus profundum, *or be any way dilated, but it muſt ſuffer ſome Diffraction or Solution of Continuity*, more or leſs. For, inſomuch as each particle of the ſuperfice doth poſſeſs a peculiar part of ſpace proportionate to its dimenſions; and though upon the Dilatation of the ſuperfice, *i. e.* the remove of its particles to a more lax order, greater ſpaces are intercepted among them, yet are not the particles multiplied in number, nor magnified in dimenſions, and ſo cannot poſſeſs more or greater ſpaces than before: therefore is it neceſſary, that the ſuperfice be variouſly crackt, and the continuity thereof infringed in many places. The Neceſſity hereof doth farther evidence it ſelf in the Flexion of a Twig, Cane, or other [καμπτὸν] *Flexile* body; for, when a Twigg is bended, as the Concave ſuperfice becomes Contracted and Corrugated, the particles thereof being not able to penetrate each other, nor crowd themſelves into fewer places: So at the ſame time, is the Convex Dilated, and ſuffers many ſmall breaches or cracks, the particles thereof being uncapable either to multiply themſelves, or poſſeſs more ſpaces, than before. The ſame likewiſe is eaſily intelligible in a *Tractile* body, ſuch as (*Ariſtotle* names Ἑλκτὸν) a Nerve, or Luteſtring: for allbeit the interruption of Continuity be not ſo manifeſt to the ſenſe in a Tractile as in a Flexile body: yet may we obſerve, that when a *Tractile* body is extended or drawn out in length, it is extenuated or diminiſhed in thickneſs. And, what, think you, becomes of thoſe interior particles, which compoſe its Craſſitude or thickneſs? Certainly, they muſt come forth

forth into the ſuperfice, that ſo they may interpoſe themſelves among the Diſſociated particles thereof, poſſeſs the void ſpaces left betwixt them, and with their ſmall clawes or hooks on each hand cohæring to them, make the ſuperfice apparently continued. Would you obſerve the Interruption of Continuity among the ſuperficial particles of a Tractile body, and the iſſuing forth and intermiſtion of interior particles among them; be pleaſed to paint over a Luteſtring with ſome oyled Colour, and afterward verniſh it over with oyle of Turpentine: then ſtrain it hard upon the Lute, and you ſhall plainly perceive the ſuperfice of it to crack and become full of ſmall clefts or chinks, and new particles (not tincted with the colour) to iſſue forth from the entralls of the ſtring, and interpoſe themſelves among thoſe ſmall breaches. Laſtly, the ſame is alſo diſcoverable by the ſight in a *Ductile* body [Ἐλαΐον] ſuch as every Metal; for, no metal, when preſſed or hammerd, is dilated or expanded on all ſides, for any other reaſon but this, that it is as much attenuated in thickneſs, and the particles in the ſuperfice are ſo diſſociated, as that the interior particles riſe up, poſſeſs the deſerted ſpaces, and cohære to the diſcontinued exterior particles, as may be more plainly diſcerned if the ſuperfice of the Metal be tincted with ſome colour.

SECT. II.

Art. 1. Flexility, Tractility, Ductility, &c. derived from *Softneſs*: and *Rigidity* from *Hardneſs.*

FRom the Præmiſes, whereupon we therefore inſiſted ſomewhat the longer, it is manifeſt, that FLEXILITY, TRACTILITY, DUCTILITY, and other Qualities of the ſame Claſſis, are all the Conſequents of Softneſs: as the Contrary to them all RIGIDITY, is the Conſequent of Hardneſs; inſomuch as whoever would frame to himſelf an exact notion of a Rigid body, meerly as a Rigid, muſt compoſe it of the Attributes, inflexile, intractile, inductile.

Art. 2. PROBLEM. What is the Cauſe of the motion of *Reſtoration* in Flexiles? and the SOLUT.

Nor doth any thing remain to our clear underſtanding of the nature of FLEXILITY, but the Solution of that great Difficulty, *Cur flexilia, poſtquam inflexa fuerint, in priſtinum ſtatum reſiliant?* Why a flexile body, ſuch as a Bowe of wood, Steel, Whalebone, &c. doth, after flexion, ſpring back again into its natural figure and ſituation?

The Reaſon of this Faculty of *Reſtitution*, we conceive (with the immortal *Gaſſendus*) to be this; that the Recurſe or Reſilition of a flexile body is a certain Reflex motion, which is continued with a Direct motion: as we ſhall have opportunity profeſſedly to demonſtrate, in our ſubſequent Enquiry into the nature of Motion. In the mean while, it may ſuffice to ſtay the ſtomach of Curioſity, that we evidence the cauſe of it to be the ſame with that of the Rebound of a ball, impelled by a racket, from a Wall: for, as the force, which makes the ball rebound from the wall, is the very ſame which firſt impelled it againſt the Wall; ſo is the force, which reflecteth a bowe, after bending; the very ſame which bended it. To *Exemplifie*; when a man layes a ſtaff tranſverſly upon

upon a beam, and ſtrikes the end that is toward him, downward; the end that is from him, muſt riſe, as much upward: as well becauſe of the reſiſtence of the beam (which here performs the office of an *Hypomochlion*, or middle Fulciment) as of the continuity and compactneſs of the ſtaff it ſelf; and ſo the ſame cauſe, the hand of the man, which impelled the one extreme of the ſtaff downward, is alſo the cauſe of the riſing of its other extreme upward. Again, let the ſtaff have liberty of play between two beams, the one above, the other beneath it; and upon the Depulſion of one end, the other ſhall riſe up, and be impinged againſt the upper beam, and from thence rebound back again upon the lower, and thence again to the higher, and thence again to the lower, and ſo alternately be reflected from one to the other, till the force of reſiſtence in the 2 beams hath wholly overcome that of the firſt percuſſion or impulſe: yet ſtill doth the laſt Rebound, no leſs than the firſt, owe it ſelf to the ſame Cauſe, which impreſſed the firſt motion upon the ſtaff, which was the hand of the man, who impelled it. To approach one degree neerer; ſet up a ſtaff perpendicularly in ſome hole in the floore or pavement, ſo that it may have ſome liberty of motion to each hand: and then, if you impel or inflect the upper extreme to the right hand, the part of the lower extreme, which reſpecteth the upper part of the right ſide of the hole, will preſs upon the ſame, and the other ſide of the lower extream, where it toucheth the loweſt part of the left ſide of the hole, ſhall be at the ſame time impinged likewiſe againſt the left ſide; and that ſo forcibly, that it ſhall rebound from thence to the oppoſite ſide, and at the ſame time, the upper part, which you inflected, ſhall rebound from the right to the left: and thus ſhall the ſtaff be agitated from ſide to ſide, by alternate reſilitions, till the reſiſtence of the hole hath wholly overcome the force thereupon impreſt, by your hand. This laid down, we infer, that the cauſe of Returne in the ſtaff, is the ſame with that of the Self-reſtorative motion in bodies Flexile; for, that you may be able to inflect one end of the ſtaff, it is neceſſary, that ſome part of it be held faſt in your hand, ſome hole, chink, or other hold, that ſo you may diſtinguiſh the *Hypomochlion*, or point of Reſt, from the part inflected.

Art. 3. Two *Obſtructions* expeded.

Nor is it ought available to the contrary, to *Object* (1) that the ſtaff is not bent with one ſingle ſtroke, but a continent preſſion: becauſe a Continent preſſion is nought elſe but a continent Repetition of ſtrokes; and that is the laſt ſtroke, immediately upon which the laſt and non-impeded Reflexion doth enſue. 2. that our Example of the Reſilition of a ſtaff is incongruous, there being a conſiderable Rigidity therein, but none in Flexile bodies: for, though there be no perfect or Abſolute Rigidity in Flexile ſubſtances, yet is there a ſufficient Firmneſs, which is a degree of Rigidity; and by how much greater that is, by ſo much the greater force of impulſe is required to the inflexion, and conſequently ſo much ſtronger is the Reflection. So that while the bottome of the ſtaff, and its Hypomochlion alternately performe their offices, the one reflecting this, the other the contrary way, ſo many more Alternate Reflexions, or Excurſes and Recurſes are made, by how much greater the Rigidity of the ſtaff, and firme fixation in its hold, are; and *è contrà*. And, ſince the Reflection, which is made from the firmely fixt part, is as it were the *Fundamental*, or *General* Reflexion; innumerable *Special* or *Particular* Reflexions, exactly like the General,

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are made *in singulis partibus*: insomuch as the parts of the Concave superfice are so compressed, in order, one after another, from the Deflected Extrem to the Fixt, that suffering mutual resistence, they are compelled to start back in the same order, one after another; and the parts of the Convex superfice, from the Fixt Extreme to the Deflected, are so retracted in order one after another, that they return in order to their natural site; and some parts thus conspiring with others, reduce the whole inflected bodie to its natural situation and figure.

Art. 4. Why *Flexile* bodies grow weak, by overmuch, and over frequent Bending.

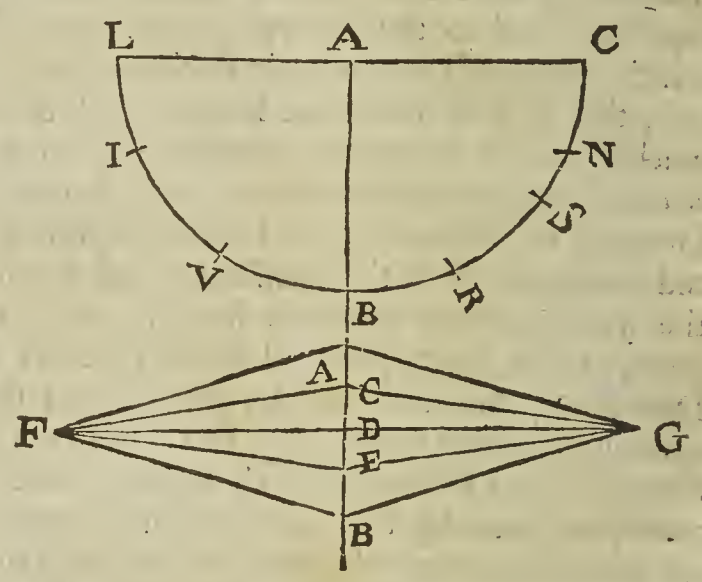
Finally, because every Reflex Motion is alwaies (though, perhaps, not sensibly) weaker, than the Direct; therefore is it, that in every Deflexion, both to the Concave superfice, some particles subingress to the interiors of the Flexile bodie, which cannot returne forth again to the superfice; and to the Convex, other particles egress to the superfice, which cannot returne in again to the interiors: Whereupon it comes to pass, that by how much the longer the Inflexion is continued, or how much the more frequently repeated; by so much the more Contracted is the Concave superfice made, and so continues, and so much more Deduced or Dilated is the Convex superfice made, and so continues; and consequently both the Inflexion and Reduction become as so much the weaker, so as much the smaller. Nay, where the Deflexion is so great, as that some parts of either superfice are wholly Diffracted and Dissociated, and so can no longer maintain that mutual cohærence and continuity, which is necessary to the series of Reflexion and Retraction: there doth no Reduction at all followe, after Inflexion, at most only so much, as is made by the parts, which yet remain cohærent, in which also we must allowe the distinction of Concavity and Convexity. Thus, when a Twigg is broken half off in the middle, by overmuch bending; it makes no more Reflexion, than what depends only upon the half which is unbroken.

Art. 5. The Reason of the frequent *Vibrations*, or *Diadroms* of Lutestrings, & other *Tractile* Bodies; declared to be the same with that of the *Restorative Motion* of *Flexiles*: and Demonstrated.

As for TRACTILITY likewise, all the obscurity which remains upon its nature, depends upon this Difficulty; *Cur Nervus distentus, & è suo situ distractus toties hinc inde redeat?* Why doth a Tractile bodie, such as a Nerve or Lutestring, when distended, and abduced from the line of direction to either side, not only reduce it self from that obliquity to directness; but recurr beyond it, and then returns toward the place of its first abduction, and thence back again to and beyond the line of direction, and so makes many excurses and recurses?

And this may be soon solved, by *Answering*; that the Cause of this Tremulation or Vibrations of a Tractile thing, distended and percussed, or abduced, seems to be the same with that of the Reflexion of a Flexile, newly rendred. For (1.) A chord distended, is nothing but a Flexile body; and so much the more apt for Reflection, by how much more it is Distended: because Tension is a kind of Rigidity. (2.) A chord distended hath the reason not only of one simple Flexile bodie, but also of two conjoyned; insomuch as it hath 2 Extrems, in each of which we may distinguish the Hypomochlion, or fixt part, from the Reflectent; and in the middle, or that part, which is percussed or abduced by the plectrum or finger, there are as it were 2 other Extrems

tremes conjoyned, which being naturally reluctant each to other, cauſe the reciprocal Reduction each of other. (3.) As a Twigg, after inflexion, doth return beyond the middle, or line of directneſs, and goes and comes frequently, till it hath overcome the firſt impreſſed motion, and recovered its natural ſite becauſe after the firſt Reflexion is made, a ſecond ſucceeds, for the ſame reaſon, as the firſt, a third for the ſame reaſon as the ſecond, and ſo a fourth, fifth, &c. ſucceſſively: So alſo, is it neceſſary, that many Vibrations, or Excurſes and Recurſes be alternately made, by a Chord diſtended and percuſſed; becauſe the ſame cauſe remains to the ſecond, third, fourth, &c. which was to the firſt. *Lege Merſennum, Harmonicor. lib. 3. Propoſ. 22. Corollario de Atomis.*



This may be fairly demonſtrated in this Chord A. B. vertically diſtended, by a weight appenſed. For, being elevated to the point C. falling from thence, it will make its firſt diadrome to I. not to L. becauſe of the reſiſtence of the Aer: and thence by new force returning over the center B. it will make it ſecond diadrome, not quite home to N. becauſe of the reſiſtence of the Aer, but only to S. and thence relapſing, it will make its third diadrome no higher then V. and thence back again, its fourth to R. and at length, its diadroms ſucceſſively diminiſhing, it reſteth at the centre B. And thus you ſee how the force or impetus, whereby it is moved, is by ſenſible degrees and proportionately diminiſhed: and that it is impoſſible, it ſhould make any two Diadroms Æquiſpatial, during the whole time of its motion. For, if we concede two diadroms to be equal in ſpace; we muſt find them to be produced by an equal impetus. Therefore, if the Chord recurring from C. ſhould on the other ſide aſcend as high as L. it would of neceſſity thence returning make its ſecond Diadrome to C. where it began its firſt, and thence recur to L. again, and thence to C. and ſo the motion would be perpetual. Leſt, therefore, that Abſurdity be admitted in nature, it is neceſſary that the impetus be proportionately diminiſhed, that ſo the Chord may after various Vibrations arrive at the centre or terme of its motion. You ſee alſo, that the Natural impetus, by whoſe ſwindge or rapt, the weight appenſed at the lower extreme of the Chord, is carried to the Centre, is the Cauſe of all its Tranſcurſions or diadroms: and that the Reſiſtence of the conſtipated or compreſſed Aer, is the cauſe of the Diminution of them.

But

But here comes the PROBLEM (ſuch a one as put even *Merſennus* Himſelfe to the *Eruditis Phyſicomathematicis diſcutiendum relinquo; Harmonicor. lib. 2. propoſit. 29.*) and that is; *Cur Diadromus Chordæ maximus eodem tempore conficit totum ſpacium, quo minimus, aut reliqui ſinguli diadromi intermedii illud conficiant?* Whence is it, that all the Excurſes and Recurſes, or diadroms of a Chord, either Vertically, or horizontally diſtended, and abduced from the line of Direction; are Iſochronical, or Æquitemporaneous, though not Æquiſpacial: as alſo are All the Vibrations of a Flexile body, fixt at one extream, and deflected at the other.

Art. 6. PROBLEM. Why the Vibrations, or Diadroms of a Chord diſtended and percuſſed, are *Æquitemporaneous*, though not *Æquiſpatial*: and the SOLUT.

This ſtupendious Phænomenon may be thus Demonſtrated. Let F. G. (in the ſecond diagram) be the Chord horizontally diſtended; which, being diſtracted from its direct ſituation, F. G. to A. makes its ſeveral Diadroms, A.B. B.C. C.E. and E.D. Now we ſay, that All theſe Diadroms, though greatly diſproportionate in point of ſpace, are yet exactly proportionate in point of Time, *i. e.* the firſt Diadrom, A. B. doth meaſure its whole ſpace, in the ſame proportion of time, as doth the ſecond Diadrom, B. C. or the third, C. E. or the fourth E. D. For, ſince the Violence or impetus, whereby the Chord is abduced from the line F. G. to the point A. is ſo much the greater, by how much the longer the line of the Epidrom is, the Chord muſt pervade it ſpace ſo much the more ſpeedily, by how much the ſpace is greater, compared to that of the ſubſequent ones: it neceſſarily followes, that all the ſubſequent Diadroms muſt be Æquidiurnal, becauſe look how much is detracted from the Longitude, Magnitude, and Impetus of the ſubſequent Diadroms exactly ſo much accedeth to the Brevity of the ſpace, which they are to percurr; and ſo the longitude of the poſterior Epidrom becomes inverted in proportion to the Time, and its Brevity of ſpace compenſateth the decay of that Impetus, which was in the Prior Diadrom. For Example; Let the Chord, which makes an hundred Diadroms, pervade a foot ſpace, in its firſt Diadrom, and the hundredth part of a foot, at its laſt, or hundredth Diadrom: we affirm, that the firſt Diadrom muſt be an hundred times ſwifter than the Laſt; which is an hundred times ſlower, as being to the ſame proportion leſs violent, and that which immediately præcedeth the Quiet of the Cord, in the Direct line, F. G.

More plainly; the Firſt Diadrom, A. B. as it is the Greateſt, ſo is it the moſt Violent; and as it is the moſt Violent, ſo muſt the Velocity, whereby it pervades the whole ſpace betwixt A.B. be alſo the Greateſt: and the Second Diadrom, B. C. how much it comes ſhort, in violence of tenſion, and Celerity of motion, of the Firſt, ſo much doth it come ſhort of the Magnitude alſo thereof; ſo that though the ſpace of the former, A. B. be much larger than that of the ſecond, B.C. yet doe they both pervade their ſeveral ſpaces in the ſame proportion of Time, becauſe, as the ſecond Diadrom, B. C. hath leſs of violence and of Celerity, than the firſt, A. B. ſo hath it juſt ſo much leſs of ſpace to pervade, and ſo the Diminution

nution of space Compensateth the Diminution of Violence and Celerity. Wherefore, the Reason of the Third Diadrom being the same to the Second, as that of the Second to the First; and of the Fourth to the Third, as that of the Third to the Second: it is manifest and necessary, that all the Diadroms be Æquidiurnal, though not Æquispatial; which is what we Assumed.

Art. 7. PROBLEM. Why doth a Chord of a duple length, perform its diadroms in a proportion of time duple, to a Chord of a single length; both being distended by equal force; & yet, if the Chord of the duple length be distended by a duple forc or weight, it doth not perform its Diadroms, in a proportion of time duple to that of the other; but only if the Force or weight distending it, be quadruple to the First supposed: and its SOLUT.

But yet the Lees of the PROBLEM remain behind; for it is worthy farther Enquiry: *Why a Chord of a Duple length, v. g. of 4 foot, doth performe its Diadroms in a Duple proportion of Time, to a Chord of a single length, v. g. of 2 foot; when both are distended by equal Force, or Weight: and yet, if the Chord of 4 foot be distended by doubly as great a Force or Weight as that of only 2 foot, it doth not performe its Diadroms with Velocity Duple thereunto; but only if the force of its Distension be Quadruple to the force first supposed?*

And to exhaust them, though somewhat rough and crabbed, we ANSWER, As in a *Pensile* bodie, or Chord vertically distended by a weight, the time of each single Excurse, is equal to that time, in which the same weight would, if permitted, be falling from such an Altitude, as is commeasurable by the diametre of the Circle, whereof Arches are described by the Excurses of the Pensile body abduced from the perpendicular: So in a *Tensile* body, such as a Chord strained upon a Lute, All the times, in which a part of the Chord accepted exactly in the middle, excurreth from one side, are equal to one time, in which one of its Extrems, if cut off, would directly pervade the whole length, and come into the place of the other, toward which the force, being still the same behind, would draw it. For, the same Force, certainly, is alwaies able to produce the same Effect: and if the lateral spaces of the Diadroms doe continually decrease; the Velocity of the motion must also continually decrease. And the cause of that continual Decrement, can be no other but the Force Drawing or distending the Chord, which continually refracteth the contrary Force, by the plectrum or finger impressed thereupon. Now, since All the Excurses of a Chord, of whatever length, are exæquated to one and the same direct Trajection thereof, as we said even now; in the *Former* Case, the Trajection cannot but be performed in a duple proportion of Time, as a Duple proportion of Space is assumed to be trajected or pervaded, by the same Motive or Attractive Force: but in the *Latter* not, because Three Equal things being supposed, *viz.* Time, Space, and the Weight or Attractive Force, it is of pure necessity, that the same space remaining, look how much of Time is diminished, so much is the motive Force encreased, and what is the proportion of space to Time, the same is the proportion of the Motive Force to Space. And hence comes it, that the proportion of space to Time being as that of 2 to 1; the Motive Force must have to space the proportion of 4 to 2: and consequently to Time, not as 2 to 1, but as 4 to 1.

Lastly,

Laſtly, as for DUCTILITY, little remains Additional to what we have formerly ſaid, concerning the Formal Reaſon thereof, but the Solution of that notable PROBLEM, about the admirably vaſt *Extenſibility* of that King not only of Metals, but of the whole Earth, *Gold.* And, indeed, ſince we have it upon the teſtimony of our Experience, that one Ounce of pure Gold may be, by Malleation, extended to ſuch an amplitude, as to cover ten Acres of Land; and that one Grain thereof may be Wier drawne into a thread of ſuch incomparable fineneſs, as to commenſurate 400 foot; and conſequently, that one Ounce of Gold is capable of deduction into a thread, whoſe length may fufill the meaſure of two hundred and thirty thouſand, and four hundred feet, of ſix inches apiece: we ſay, this being avouched by thoſe Mechaniques, who deale in Beating of Gold into Leaves, and Drawing it out into Wier, it ſeems well worthy our Enquiry, upon what Cauſe this ſtupendious Prærogative of Gold doth chiefly depend. In a word, therefore, we conceive this ſuperlative EXTENSIBILITY of Gold, to be warrantably referrible to a *Threefold Cauſe*, *viz.* the unparalleld Compactneſs of it ſubſtance, the great Tenuity of its Component particles, and the Multitude of ſmall Hooks or Clawes, whereby thoſe particles reciprocally implicate each other, and maintain the Continuity of the whole Maſs. For (1) the *exceeding Compactneſs of its Contexture* doth afford parts ſufficient to ſo great Extenſion, *i. e.* ſuch an abundance of them, as upon the Decrement of the Maſs in Profundity, may riſe up into the ſuperfice and enlarge the Latitude, or Longitude: (2) The *Tenuity of its component particles* maketh the maſs capable of Diminution in profundity, and ſo of Augmentation in ſuperfice, even to an incredible proportion: and (3) The *Multitude of ſmall Hooks*, whereby thoſe Exile particles reciprocally cohære, ſufficeth to the conſtant Continuity; for, while the maſs is ſuffering under the Hammer, no ſooner can the ſtroke thereof diſſociate one particle from its neighbour, but inſtantly it layes hold of and faſtneth upon another, and as firmely cohæreth thereunto, as to its former hold: So that the mutual Cohæſion is maintained even above the higheſt degree of Extenſion or Attenuation, which any imaginable Art can promiſe. Nay, ſo ſufficient a Cauſe of incredible Ductility doth this laſt ſeem to be, that *Merſennus* regarded no other: as may be collected from theſe his words: *Sunt autem Corpora maximè Ductilia, quæ habent Atomos undique Hamatas, ut Aurum; cujus Atomi non ita poſſunt evolui, ut ſeſe deſerant in inferioribus, aut ſuperioribus partibus, quin laterales ſuccedant, quibus uſque ad inſignem tenuitatem perveniant*; (*Harmon. lib. 3. propoſ. 22. Corollario de Atomiſ.*) This apprehended, the Chymiſt needs not longer to perplex himſelf about the Cauſe of the *Incorruptibility*, and *incapacity of Volatilization* in Gold: and if his ſo promiſing Art can attain to the inveſtment of any Metal with theſe Proprieties; let other men diſpute, whether it be Gold or no, for our parts, we oblige our ſelves ſo to accept it.

Art. 8. The Reaſons of the vaſt *Ductility*, or *Extenſibility* of *Gold.*

Now, that we may run through all other Secondary Qualities, in this one Courſe, we farther obſerve; that to the prædominion of Softneſs, men ought to refer SECTILITY, ſuch as is ſeen in wood Cut transverſly: and FISSILITY, ſuch as in wood cleft along the Grain. For, whatever

Art. 9. *Sectility* and *Fiſſility*, the Conſequents of *Softneſs.*

whatever is [τὸ τμητὸν] *Sectile*, muſt in ſome ſort return to the nature of *Flexility*; ſeeing that the parts of it, which are immediately preſſed upon by the edge of the Axe, Knife, or other Cutting inſtrument, muſt recede inwardly, *i.e.* from the ſuperfice to the profundity of the Maſs, and the Lateral parts, at the ſame time, give back on each hand, for otherwiſe there could be no yeilding, and ſo no cutting; and in like manner, whatever is [τὸ χιστὸν] *Fiſsile*, muſt have ſo much of Flexility alſo, as that, when the parts of it, in the place, upon which the Force is firſt diſcharged, begin to be diſſociated, a certain Compreſſion muſt run along ſucceſſively to all the other parts, which are afterwards to be diſſociated. But, though a *Fiſsion*, or Cleaving may be made without any Deperdition of Subſtance, or exceſſion of parts from the body cleft; thoſe parts, which were coadunated *Sec. Longitudinem*, being only ſeparated *Sec. Longitudinem*: yet is that impoſſible in any *Section* whatever, though made by the acuteſt edge imaginable; becauſe, look how much of the body doth commenſurate the bredth of the edge of the Cutting inſtrument, ſo much, at leaſt, is beaten off and deſtracted from the body, betwixt the ſides of the inciſion. And thus much concerning the Conſequents of *Softneſs*.

Art. 10. *Tractility* and *Friability*, the Conſequents of *Hardneſs*.

As for thoſe of *Hardneſs*; they are TRACTILITY and FRIABILITY. For, whatever is [τὸ κρατικὸν] Fractile, capable of fraction into pieces, as a Flint and moſt other ſtones, muſt have ſo much of *Rigidity*, (the chief propriety of Hardneſs) as may ſuffice to hinder the yeilding of it ſuperfice, upon preſſure or percuſſion; and conſequently all ſubingreſſion of ſuperior particles into the ſmall vacuities intercepted among the inferior ones; and ſo to cauſe, that the ſuperfice is firſt diffracted, and ſucceſſively all the ſubjacent particles diſſociated, quite thorow to the contrary ſuperfice, the inferior particles being ſtill pulſed by the Superior [κατὰ τὸ ζυνεχὲς] by reaſon of their Continuity. So that the fragments into which the body is ſhattered, are greater or leſs, either according to the diverſe contexture thereof in divers parts, in reſpect whereof ſome parts may be contexed more Compactly and Firmely, and others again more Laxly and Weakly: or according to ſituation, in reſpect whereof thoſe parts, which are neerer to the Circumference, flie off more eaſily than thoſe, which are more remote. In like manner, whatever is properly [τὸ θραυστὸν] *Friabile*, *Brittle*, as Marble, Glaſs, Earthern Veſſels, &c. muſt alſo have ſo much of Rigidity, as to make it uncapable of Flexion, Traction, Diduction, or Extenſion, by any means whatever: ſo that upon any forcible preſſion, or percuſſion, the whole maſs or ſubſtance of it is ſhivered into duſt, or broken into greater fragments, which are eaſily ſubject to be Crumbled into duſt afterward. Now, that a Hard or Rigid bodie being percuſſed, or preſſed, with force ſufficient, in one Extreme or Superfice, the percuſſion or preſſure may be propagated from part to part ſucceſſively, till it arrive at and be determined in the other extreme; may be evinced by ſundry moſt eaſie Experiments, ſome whereof are recited by the *Lord St. Alban* (*in Sylva ſylvarum Cent.* 1.) But this one will ſerve the turne. When an Oyſter, or Tortois ſhell is let fall from a ſufficient altitude, upon a ſtone, it is uſually ſhattered into many peices; and that for no other Reaſon but this, that the lower ſide, whether Convex or Concave, being

being vehemently impinged against the stone, the particles thereof immediately knockt by the stone, as vehemently give back, and in their quick Retrocession impell the particles situate immediately above them; whereupon those impelled particles with the same violence impell others next in order above them, until the percussion being propagated from part to part successively quite home to the upper superfice, it comes to pass, that each percussed part giving back, the whole shell is shattered into small Fragments.

All which may seem but a genuine Paraphrase upon the Text of *Mersennus*. (*Harmonicor. lib.* 2. *propos.* 43.) *Duritiei verò proprietas appellatur Rigiditas; quæ fit ab Atomis ita sibi invicem cohærentibus, ut Deflexionem impediant: quod contingit in Corporibus, quæ constant Atomis Cubicis, octuedris & tetruedis, ex quibus resultat perfecta superficiecularum inter se cohæsio; hinc fit ut Rigida Corpora Fructilia sint, non autem Sectilia, & ictu impacto tota in frusta dissiliant. Qui adum prædictæ superficiunculæ se invicem premunt, quæ sunt ex una parte, dimoventur ab iis, quæ ex alia; adeo ut unico impetu externo Corpori impresso, Contusio sentiatur per totum, & partium eodem, momento fit separatio.*

There yet remains a Quality, which is the Ofspring neither of Softness alone, nor Hardness alone; but ought to be referred partly to the one, partly to the other: and that is RUPTILITY. For, not only such Bodies, as challenge the Attribute of *Softness*, are subject to *Ruption*, when they are distressed beyond the tenour of their Contexture, either by too much *Inflexion*, as a Bow over bent; or too much *Distention*, as Leather or Parchment over strained; or too much *Malleation*, as a plate of Lead, Iron, or other Metal over hammerd: but such also as claim the title of *Hardness*, and that in an eminent proportion, as Marble; for, a Pillar of Marble, if long and slender, and laid transversly or horizontally, so as to rest only upon its two extrems, is easily broken asunder by its own Weight. For, as Soft bodies, when rackt or deduced beyond the rate of mutual Cohærence among their parts, must yeeld to the External Force, which distresseth them, and so suffer total discontinuity: so Hard ones, when the Internal Force, or their owne Weight, is too great to be resisted by their Compactness, as in the example of a long Marble Pillar, not supported in the middle; then must they likewise yeeld to that superior force, and break asunder.

Art. 11. *Ruptility*, the Consequent partly of *Softness*, partly of *Hardness*.

And here the *Archer* and *Musician*, put in, for a Solution of that PROBLEM, which so frequently troubles them; *viz. Cur Chordæ facilius circa Extrema, quam circa Medium frangantur, cum vi vel pondere, sive horizontaliter, sive verticaliter trahuntur?* Why Bowstrings, Lutestrings, and other Chords, though of uniforme Contexture throughout, and equally distended in all parts, do yet usually break asunder, not in the middle, or neer it, but at one End, where they are fastned?

Art. 12. PROBLEM. Why Chords distended, are more apt to break neer the *Ends*, than in the middle? and its SOLUT.

The *Cause*, certainly, must be this; that the Weight or drawing force doth alwayes first act upon the parts of the string, which are neerest to it, and successively upon those, which are fartherest off, *i. e.* in the Middle: so that the string suffering the greatest stress neer

the Extrems, is more ſubject to break there, than in any other part. Wherefore, whenever a Bowſtring breaks in or neer the middle; it may ſafely be concluded, that the ſtring was weakeſt in that place. To which we may add this alſo, that Experienced Archers, to prævent the frequent breaking of their ſtrings, and the danger of breaking the Bow thereby; injoyn their String-makers, to add a Link of Flax, or Twiſt more at the Ends of each ſtring, than in any other parts of it: and that they call the *Forcing*, becauſe Experience hath taught them, that the Force of the Bow is moſt violently diſcharged upon thoſe parts of the ſtring, which are neereſt to the Horns.

CHAP.

CHAP. XV.

OCCULT QUALITIES made MANIFEST.

SECT. I.

HAving thus long entertained it self with the most probable Reasons of the several wayes and means, whereby Compound Bodies exhibite their several Attributes and Proprieties to the judicature of the Sensitive Faculties in Animals, and principally in Man, the Rule, Perfection and grand Exemplar of all the rest; tis high time for our Curiosity to turn a new leaf, and sedulously address it self to the speculation of Another Order, or Classis of Qualities, such as are vulgarly distinguished from all those, which have hitherto been the subject of our Disquisitions, by the unhappy and discouraging Epithite, OCCULT. Wherein we use the scarce perfect Dialect of the Schools; who too boldly præsuming, that all those Qualities of Concretions, which belong to the jurisdiction of the senses, are dependent upon Known Causes, and deprehended by Known Faculties, have therefore termed them *Manifest*: and as incircumspectly concluding, that all those Proprieties of Bodies, which fall not under the Cognizance of either of the Senses, are derived from obscure and undiscoverable Causes, and perceived by Unknown Faculties; have accordingly determined them to be *Immanifest* or *Occult*. Not that we dare be guilty of such unpardonable Vanity and Arrogance, as not most willingly to confess, that *to Ourselves all the Operations of Nature are meer Secrets*; that in all her ample catalogue of Qualities, we have not met with so much as one, which is not really Immanifest and Abstruse, when we convert our thoughts either upon its Genuine and Proxime Causes, or upon the Reason and Manner of its perception by that Sense, whose proper Object it is: and consequently, that as the *Sensibility* of a thing doth noe way præsuppose its *Intelligibility*, but that many things, which are most obvious and open to the Sense, as to their *Effects*, may yet be remote and in the dark to the

Art. I. That the *Insensibility* of Qualities doth not import their *Unintelligibility*; contrary to the presumption of the *Aristotelean*.

the Understanding, as to their *Causes:* so on the Contrary, doth not the *Insensibility* of a thing necessitate, nay, nor aggravate the *Unintelligibility* thereof, but that many things, which are above the sphere of the Senses, may yet be as much within the reach of our Reason, as the most sensible whatever. Which being præcogitated, as, when we look back upon our præcedent Discourses, touching the Originals and Perception of Sensible Qualities, we have just ground to fear, that they have not attained the happy shoar of verity, but remain upon the wide and fluctuating ocean of meer Verisimility: So also, when we look forward upon our immediately subsequent Disquisitions into the Causes of many Insensible Qualities, are we not destitute of good reason to hope, that though we herein attempt the consignation of Consentaneous and Probable Causes to sundry of those Effects, which Schollars commonly content themselves only to Admire, and without farther exercise of their Intellectuals, to leave wrapt up in the Chaos of *Sympathies* and *Antipathies*; yet will not the Ingenious misunderstand us, or conceive that we esteem or propose those Reasons as *Oraculous* or *Apodicticall*, or create an expectation of the Discovery of such Originals, whereupon those Rarer Operations and Magnalia of Nature do proximely and genuinely depend. However, some may think it expedient for us to profess, that as in our former Enquiries, so in *this*, our Designe is only to explain sundry admired Effects, by such Reasons, as may appear not altogether Remote and Incongruous, but *Consentaneous* and *Affine* to Truth; that so no mans judgement may be impeached by embracing them for most Probable, untill the (in that respect, too slow) wheel of Time shall have brought up some more worthy Explorator, who shall wholly withdrawe that thick Curtain of obscurity, which yet hangs betwixt Natures Laboratory and Us, and enrich the Commonweal of Letters, by the discovery of the Real Verity. And this we must enterprize, by continuing our progress in the allmost obliterated Tract, that *Epicurus* and *Democritus* so long since chalk'd forth; not by treading in the beaten road of *Aristotle* and his *Sectators*, who (for ought we have learned) were They, who first founded that ill-contrived Sanctuary of Ignorance, called *OCCULT QUALITIES.*

Art. 2. Upon what *grounds*, and by *whom*, the Sanctuary of *Occult Qualities* was erected.

For, generally setting up their rest in the Commistion of Elements, and their supposed Immateriall Qualities; and being not able ever to explicate any Insensible Propriety, from those narrow and barren Principles: they thought it a sufficient Salvo for their Ignorance, simply to affirme all such Proprieties to be *Occult*; and without due reflection upon the Invalidity of their Fundamentals, they blushed not to charge Nature Herself with too much Closeness and Obscurity, in that point, as if she intended that all Qualities, that are *Insensible*, should also be *Inexplicable.*

Art. 3. *Occult Qualities* and *profest Ignorance*, all one.

The ingenious *Sanchez*, among many Sceptical Arguments of the Uncertainty of Sciences, seasonably urgeth this one, as very considerable, against Physiologists; *that when any Natural* Problem, such as that of the Attraction of Iron by a Loadstone, of straws by Amber, &c. is objected to them; instead of setting their Curiosity on work to in-

to inveſtigate the Cauſes thereof, they lay it in a deep ſleep, with that infatuating opium of Ignote Qualities: and yet expect that men ſhould believe them to know all that is to be known, and to have ſpoken like Oracles concerning that Theorem; though at the ſame inſtant, they do as much as confeſs, that indeed they know nothing at all of its Nature and Cauſes. For, what difference is there, whether we ſay, that ſuch a thing is Occult; or that we know nothing of it?

Art. 4. The Refuge of *Sympathies* and *Antipathies*, equally obſtructive to the advance of Natural Science, with that of *Ignote Proprieties*.

Nor is it a Courſe either leſs diſhonorable to the Profeſſors, or dangerous to the Students of Philoſophy, to refer ſuch Effects, upon which men commonly look with the eye only of Wonder, to Secret *Sympathies* and *Antipathies*: foraſmuch as thoſe Windy Terms are no leſs a Refuge for the Idle and Ignorant, than that of Occult Proprieties, it being the very ſame in importance, whether we have recourſe to the One, or to the other. For, no ſooner doe we betake ourſelves to *Either*, but we openly confeſs, that, all our Learning is at a ſtand, and our Reaſon wholly vanquiſht, and beaten out of the field by the Difficulty propoſed. We deny not, that moſt, if not All of thoſe Admired Effects of Nature, which even the Graveſt Heads have too long thought ſufficient Excuſes of their Deſpair of Cognition, do ariſe from ſome *Sympathy*, or *Antipathy* betwixt the Agent and Patient: but yet for all that, have we no reaſon to concede, that Nature doth inſtitute or Cauſe that ſympathy or Antipathy, or the Effect reſulting from either, by any other Lawes, or Means, but what ſhe hath ordained and conſtantly uſeth, to the production of all other Common and familiar Effects. We acknowledge alſo, that *Sympathy* is a certain *Conſent*, and *Antipathy* a certain *Diſſent* betwixt Two Natures, from one, or both of which there uſually ariſeth ſome ſuch Effect, as may ſeem to deſerve our limited Admiration: but is it therefore reaſonable for us to infer, that thoſe Natures are not ſubject unto, nor regulated by the General and Ordinary Rules of Action and Paſſion, whereto Nature hath firmely obliged Herſelf in the reſt of Her Operations?

Art. 5. That all *Attraction*, referred to Secret *Sympathy*; and all *Repulſion*, adſcribed to ſecret *Antipathy*, betwixt the Agent and Patient, is effected by *Corporeal Inſtruments*, and ſuch as reſemble thoſe, whereby one body Attracteth, or Repelleth another, in *ſenſible* and *mechanique* operations.

To lance and cleanſe this Cacoethical Ulcer, to the bottom, Conſider we, that the *General Laws* of Nature, whereby ſhe produceth All Effects, by the Action of one and Paſſion of another thing, as may be collected from ſundry of our præcedent Diſcertations, are theſe: (1.) That every Effect muſt have its Cauſe; (2) That no Cauſe can act but by Motion; (3) That Nothing can act upon a Diſtant ſubject, or upon ſuch whereunto it is not actually Præſent, either by it ſelf, or by ſome inſtrument, and that either Conjunct, or Tranſmitted; and conſequently, that no body can move another, but by contact Mediate, or Immediate, *i. e.* by the mediation of ſome continued Organ, and that a Corporeal one too, or by it ſelf alone. Which conſidered, it will be very hard not to allowe it neceſſary, that when two things are ſaid either to *Attract* and *Embrace* one the other by mutual *Sympathy*, or to *Repell* and *Avoid* one the other, by mutual *Antipathy*; this is performed by the ſame wayes and means, whereby we obſerve one Body to Attract and hold faſt another, or one Body to Repell and Avoid conjunction with another, in all Senſible and Mechanique Operations. This ſmall Difference only allowed, that

that in Groſs and *Mechanique* operations, the Attraction, or Repulſion is performed by *Senſible* Inſtruments: but, in thoſe finer performances of Nature, called *Sympathies* and *Antipathies*, the Attraction or Repulſion is made by Subtle and *Inſenſible*. The means uſed in every common and Senſible Attraction and Complection of one Bodie by another, every man obſerves to be Hooks, Lines, or ſome ſuch intermediate Inſtrument continued from the Attrahent to the Attracted; and in every Repulſion or Disjunction of one Bodie from another, there is uſed ſome Pole, Lever, or other Organ intercedent, or ſomewhat exploded or diſcharged from the Impellent to the Impulſed. Why therefore ſhould we not conceive, that in every Curious and Inſenſible Attraction of one bodie by another, Nature makes uſe of certain ſlender Hooks, Lines, Chains, or the like intercedent Inſtruments, continued from the Attrahent to the Attracted, and likewiſe that in every Secret Repulſion or Sejunction, ſhe uſeth certain ſmall Goads, Poles, Levers, or the like protruding Inſtruments, continued from the Repellent to the Repulſed bodie? Becauſe, albeit thoſe Her Inſtruments be inviſible and imperceptible; yet are we not therefore to conclude, that there are none ſuch at all. We every day behold Spiders letting themſelves down from high roofs, and as nimbly winding themſelves up again at pleaſure, by ſuch ſlender threads of their own occaſionall and extemporary ſpinning, as tis not every common eye that can diſcern them. Nay, in a Mask at Court, we have ſeen a whole Chorus of Gods deſcend into the theatre, as from the clouds, only by Wires and other lines, ſo fine and ſlender, as that all the light of the tapers burning therein was not ſufficient to diſcover them to the ſight of the Spectators: and vaſt aud ponderous Scenes ſo ſuddenly and dextrouſly ſhifted, by the almoſt inobſervable motions of Skrews, Elevators, Pulleys, and the like Archimedean Engines and Devices, that the common Beholders, judging only by the Apparence, or (rather) Non-apparence, have thought thoſe great machines to have been Automatous, or to have moved themſelves, and at laſt to vaniſh into nothing. And ſhall we not then allowe the incomparably more Curious Mechaniques of Natures, the Exemplar of Art, to be wrought by Inſtruments of Subtility incomparably greater: and that many of thoſe ſmall Engines, whereby ſhe uſually moves and ſuſteins bodies of conſiderable bulk and weight, are Corporeal, though by incomputable exceſſes below the perception of our acuteſt ſenſe? Certainly, for us to affirm, that nothing Material is emitted from the Loadſtone to Iron, which by continuity may Attract it; only becauſe our ſenſe doth deprehend nothing intercedent betwixt them: is an Argument of equal weight with that of the Blind man, who denied the Being of Light and Colours, becauſe He could perceive none. In a word, if there be any validity in what we have ſo plainly afferted, and frequently inculcated, touching the *Hebetude* or Groſſneſs of our *Senſes*, on one part, and the great *Exility* of all *Apporrœa*'s or Effuxes ſtreaming from Bodies, on the other; and if that Oracle, Reaſon, be to be heard, which ſo long ſince perſuaded *Hippocrates*, and many other, Secretaries of Nature, that moſt, if not All Bodies are [διάπνοα καὶ ζύμπνοα] *Perſpirable* and *Conſpirable*, *i.e.* that they continually emit inſenſible Effluvia's from themſelves to others: We ſay, if there be any weight in all this, men cannot think it unreaſonable in us to conceive, that thoſe Admired Effects, which they commonly

monly ascribe to Hidden Sympathies and Antipathies, are brought about by the same ways and means, which Nature and Art use in the Causation of the like Ordinary and Sensible Effects; and that the Instruments of *Natural* Attraction, Complectence, Repulsion, Sejunction, are *Corporeal*, and hold a neer Analogie to those of *Artificial*; only these are *Gross* and *Perceptible*, those *Subtile* and *Imperceptible*.

Art. 6. The Means of *Attractions* sympathetical, explicated by a convenient *Simile*.

Notwithstanding the perspicuity of these Arguments, we shall not supererogate, to heighten the lustre of so desirable a Truth, by the vernish of a convenient and prægnant *Simile*, or two. If we attentively observe a *Chamæleon* catching Gnats and other small Flyes in the Aer, for his food; we shall see him dart out a long and slender tongue, with a small recurvation at the tip, and birdlimed with a certain tenacious and inviscating moisture, wherewith, in a trice, laying hold of a Fly, at some distance from his mouth, he conveys the same into it with such cleanly speed, as exceeds the Legerdemane of our cunningst Juglers, and may have been the cheif occasion of that popular Error, *that he lives meerly upon Aer*. And when we see a peice of Amber, Jet, hard Wax, or other Electrique, after sufficient friction, to attract straws, shavings of wood, quils, and other festucous bodies of the same lightness, objected within the orbe of their Alliciency; and that with a cleanly and quick motion: Why should we not conceive, that this Electricity or Attraction may hold a very neer Analogy to that attraction of Gnats, by the exserted and nimbly retracted tongue of a Chamæleon. For (1) it is not improbable, that the Attraction of all Electriques is performed by the mediation of swarms of subtle Emanations, or Continued Rayes of exile particles, comparative to so many Chamæleons Tongues; which through the whole Sphere of their Virtue, in various points mutually intersecting, or decussating, and more especially toward their Extreams, doe not only insinuate themselves into the pores of those small and light festucous bodies occurrent, but lay hold upon several insensible Asperities in their superfices, and then returning (by way of *Retraction*) back to their Original or Source, bring them along in their twined arms, and so long hold them fast in their Complicate embraces, as the warmth and radial Diffusion, excited by affriction, lasteth. (2) All the Disparity, that can be objected, seems to consist onely in the Manner of their Return, or Retraction; the Tongue of the Chamæleon being both darted forth, and retracted by help of certain Muscles, wherewith Nature, by a peculiar providence, hath accommodated that otherwise Helpless Animal: but, Electriques are destitute of any such organs, either for the Exsertion, or Reduction of their Rayes. And this is not so great, but it may be solved, by supposing, that as if the Chamæleons Tongue were drawn forth at length by a mans hand, and not extruded by the instruments of Voluntary Motion, it would again Contract and Reduce it self spontaneously, after the same manner as Nerves and Lutestrings retract and curle up themselves, after violent Distension: so may the Rayes, which stream from an Electrique, being abduced from their fountains, not spontaneously, but by the force of præcedent Affriction, be conceived to Reduce and Retract themselves, after the manner of Sinews and Lutestrings violently extended.

(3) That such tenacious Rayes are abduced from Amber and other Electriques, is easily convincible (besides the experiment of their Attraction of convenient objects) from hence; that all Electriques are *Unctuous* and *Pinguous* Concretions, and that in no mean degree: and manifest it is, that a viscid and unctuous Bodie is no sooner Warmed by rubbing, but there rise out of it certain small *Lines* or *Threads*, which adhære to a mans finger that toucheth it, and such as may, by gentle abduction of the finger, be prolonged to considerable distance. But, however this may be controverted, and the Way of all Electrique Attractions variously explicated, according to the various Conceptions of men; the Itch of Phancy being soonest allayed by the liberty of ones singular Conjecture, in such curious Theorems: yet still is it firme and indubitable, that though the Attraction of straws by Amber, be in some sort Admirable, yet is it not *Miraculous*, as is implied in that opinion, which would have it to be by some *Immaterial* (i e. *Supernatural*) Virtue; and that it is effected by some *Corporeal*, though both impalpable and invisible Organs continued from the Attrahent to the Attracted.

Art. 7. The Means of *Abaction* and *Repulsions Antipathetical*, explicated likewise by sundry *similitudes*.

On the Other side, as for the *Abaction*, or *Repulsion* of one thing by another, in respect whereunto Vulgar Philosophers have thought and taught, that the Abacted or Repulsed doth (if an Animal) voluntarily (if Inanimate) spontaneously Flie from and avoid Conjunction with the Abacting, or Repellent, by reason of some hidden *Enmity* or *Antipathy* betwixt their Forms: though the Reasons and Manner of such *Fugation*, so far forth as concerns Animals, may be collected from our former Discourses of the Gratefulness and Offensiveness of Sensible Objects; yet shall we here farther illustrate the same by certain *Analogies* and *Similitudes*. When a *Nettle* is objected to a mans Hand, why doth He withdraw it from the same? Not upon the account of any Antipathy in his hand to the Nettle; because being bruised, or withered, no Childe but will boldly handle it: but, because the Nettle is pallizado'd with millions of small stings, or prickles, which like so many Darts, wounding the the skin, cause a pain therein, and so the man, for avoidance of harm, catcheth his hand from it, as an injurious object. Why likewise doth the *Nose* abominate and avoid *stinking Odours*, whenever they are brought neer it? Is it not because such Foetid and Offensive Odours consist, for the most part, of such sharp and pungent Particles, as holding no Correspondence to the pores and contexture of the Odoratory Nerves, are no sooner admitted, but they in a manner scratch, wound and dilacerate the Sensory? And may we not conceive those disproportionate Particles of the ungrateful Odour to be as so many small *Lances* or *Darts*, which offer the same injury to the Mammillary Processes of the brain, that the Prickles of a Nettle offer to the skin? Certainly, as the Nettle strikes its Darts into the skin, and not into the Nayles of a mans hand; because those are of too close and firm a Contexture to admit them: so doth an offensive Odour immit its painted and angular Particles into the tender smelling Nerves, and not into the skin, because its Contexture is more Compact, than to be capable of Puncture or Dilaceration thereby. Lastly, Why doth the *Eye* abhor and turne from *Ugly and Odious Objects*? Is it not only because the Visible Species emitted from such Bodies, doth consist of Particles of such Configurations and Contexture, as carry no pro-

proportion to the particles and contexture of the Optique Nerves, but ſtriking upon the *Retina Tunica*, inſtantly wound and exaſperate the ſlender and tender filaments thereof, and ſo cauſe the Eye, for fear of farther injury, to cloſe, or avert it ſelf? And are not thoſe Acute and Diſproportionate Particles, compoſing the viſible Species, worthily reſemblable to ſo many ſmall Prickles or Lancets, which though too ſubtile to wound the Skin, Noſtrils, or other parts of the body, whoſe Compoſure is leſs delicate, do yet inſtantly miſ-affect and pain the Optique Nerves, whoſe ſingular Contexture doth appropriate to them the Capacity of being ſenſible of that compunction? Now, putting all theſe Conſiderations into the ſcale together, and ponderating them with an equal hand; we ſhall find their weight amount to no leſs than this: that *as every Sympathy is diſplayd by certain Corporeal, though Inviſible Organs, comparated to Attraction and Amplectence; ſo is every Antipathy, by the like inviſible Organs, comparated to Repulſion and Sejunction*; which is what we Aſſumed.

Art. 8. The First and General Cauſes of all *Love* and *Hatred*, betwixt Animals.

Hence may we, without much difficulty, extract more than a Conjectural judgement, *What are the Firſt and General Cauſes of all Love and Hatred.* For, look what kind of Motions, whether Grateful or Ungrateful, are by the Species impreſſed upon the Nerves peculiarly inſervient to that ſenſe, by which the Object is apprehended; the very ſame are continued quite home to the Brain, and therein accordingly move and affect the Common Senſory: ſo as that, according to the *Pleaſure* or *Offence* of the Perception, there is inſtantly excited an Affection either of *Proſecution* of the thing, by whoſe ſpecies that pleaſant motion was Cauſed, and that is the Hint and Ground of *Loving* and *Deſiring* it; or of *Averſation* from it, and that is the Ground of *Hating* and *Declining* it.

Art. 9. Why things *Alike* in their natures, *love* and delight in the Society each of other: and why *Unlike* natures *abhor* and avoid each other.

Nay, the ſame may be well admitted alſo for the Cauſe, *Why things Alike in their Natures, love and delight in the Society each of other*; and on the contrary, *Why Unlike Natures abhor and avoid each other.* For, as thoſe which are *Conſimilar* in their Temperaments, affect each other with *Congenerous* and *Grateful* Emanations: So doe thoſe of *Diſsimilar* miſ-affect each other with *Diſcordant* and *Ungrateful.* And therefore it is no longer a wonder, that men Love, or Diſlike each other commonly at firſt interview, though they ſcarce know why: nor can we longer withold our Aſſent to that unmarkable Opinion of *Plato*, that *Similitude of Temperaments and ſo of Inclinations, is not only the Cement, but Baſis alſo of Amity and Friendſhip.*

SECT. II.

Art. 1. The *Scheme* of Qualities (reputed) occult.

FROM this *General* Disquisition into the Reasons of All Sympathy, and Antipathy, to which most of those Proprieties, which by Philosophers are celebrated as stupendious and Abscondite, are usually referred; we must advance to the Consideration of *Particular* instances, that by the Solution of Singulars, we may afford the greater relief to mens Curiosity, and have so many Opportunities of examining the Verisimility of our former Thesis, *that all such Effects, the knowledge of whose causes is generally despaired of, are produced by Substantial and Explicable Means.* And, in order hereunto, we shall, according to the method of the no less Acute than Judicious *Fracastorius* (*de Sympath. & Antipath. Rerum*) Distinguish All Occult Qualities into *General*, and *Special*; subdividing the *Generall* into (1) *the Conspiration of the Parts of the Universe.* and (2) *the Influx of Celestial upon Sublunary Bodies:* and the *Speciall* into such as Concern (1) *Inanimates*, (2) *Insensibles*, (3) *Sensibles.*

Art. 2. Nature's *Avoidance of Vacuity*, imputed to the tyzygia or Conspiration of all parts of the Universe; no *Occult Quality.*

To the FIRST GENERAL ORDER, *viz.* the Conspiration and Harmony of all Parts of the Universe, Philosophers unanimously ascribe the *Avoidance of Vacuity*; whereupon many are the Secrets, that are presumed to ensue, as the Ascention of Heavy, Descent of Light Bodies, the Sejunction of Congenerous and Sociable Natures, the Conjunction and Union of Discordant and Unsociable, and the like Irregular and Præposterous Effects. But, as for all these Secrets, we have long since declared them to be no Secrets, but the most ordinary and manifest operations of Nature. For, in our Examination and Solution of all the Apparences in the late famous Experiment of introducing a Vacuum in a Tube, by Water or Quick-silver, invented by *Torricellius*; we have at large proved, that Nature doth not abhor any but Sensible, or Coacervate Emptiness: nor that neither *per se*, or upon the necessity of an absolute Plenitude of all places in the Universe; but by *Accident* only, and that either in respect of the natural *Confluxibility* of the parts of Fluid Bodies, such as Aer and Water, which causeth them with great velocity to flow into the parts of Space deserted by a body passing thorow them; or of the Repugnancie of admitting two bodies into one and the same place, at the same time, their *Solidity* prohibiting the penetration of ones dimensions by the other. Wherefore, let no man henceforth account the Conspiration of the Parts of the Universe, to be an *Occult Quality*; or so much stand amazed at all or any of those *Phænomena*, which arise from Natures Aversion from Vacuity Sensible; as if they had some Extraordinary Lawes and Constitutions particularly ordained for their production, and belonged to some higher Oeconomy than that, according to which she regulates her Common Active and Passive Principles.

To

To the SECOND, *viz.* the Influx of Cælestial upon Sublunary Bodies, innumerable are the Effects, which the Fraud of some, the Admiration of many, and the Credulity of most have confidently imputed: and therefore it cannot be expected, we should, in this place, so much as Enumerate the one Half, much less insist upon them All. Sufficient it is, to the Acquitance of our præsent Debt, that we select the most considerable among them, and such as seem Capital and Comprehensive of all the rest. As for the *Power and Influence of the Stars*, of which Astrologers talk such wonders, and with such pride and ostentation; truly, we have Reason to assure us, that our Cognation and Subjection to those radiant Bodies, is not so great, as that not only All the Actions, Fortunes, and Accidents of Particular men, but even the Warres, Peace, Mutations, Subversions of whole Empires, Nations, States, and Provinces should depend upon their Smiles or Frowns: as if All Occurrents on the theatre of our Lower Orb, were but the orderly and necessary Effects of the Præscriptions and Consignations of the Superior Orbs; or as if there were no Providence Divine, no Liberty of Mans Will.

Art. 3. The *power and influence of Cælestial Bodies*, upon men, supposed by *Judicial Astrologers* inconsistent with *Providence Divine*, and the *Liberty* of man's will.

(2) As for the *Reciprocation*, or *Afflux and Reflux of the Sea*, so generally fathered upon the Influx and Motion of the *Moon*, which doth herself suffer the like Ebbs and Floods of her borrowed Light; tis well known, how *Seleucus* of old, and *Galilæus* of late, have more fully and roundly deduced it from the motion ascribed to the *Earth*. And though we should allow this great Phænomenon to depend upon the several *Adspects* or *Phases* of the Moon, yet is there no necessity to drive us to the subterfuge of any *Occult* and *Immaterial Influence* from her waxing and waning Light: since the System of *Des Cartes* (*in Princip. Philosoph. part.4. page* 220.) doth much more satisfactorily make it out, from the *Elliptical Figure* of the Sphere, wherein the Moon moves; as will soon appear to the Examiner.

Art. 4. The *Afflux and Reflux of the sea*, is derivative from any *immaterial Influx* of the Moon.

(3) As for the *Diurnall Expansion, and Conversion of the Heliotrope toward the Sun*; though great notice hath been taken thereof by the Ancients, and most of our Modern Advancers of the Vanities of Natural Magick (who will have every Plant to retain to some one of the Planets, by some secret Cognation, and peculiar sympathie.) have laboured to heighten it to the degree of a Wonder: yet can we not conceive the Effect to be so singular, nor that any such Solemne Reason need be assigned thereunto. For, every mans observation may certifie him, that all Marygolds, Tulippa's, Pimpernell, Wartwoort, Mallow Flowers, and indeed most other Flowers, so long as they are in their Vigour and Pride, use to Open and Dilate toward noon, and somewhat Close and recontract themselves after Sun set. And the *Cause* (surely) is only the Warmth of the Suns Rayes, which discussing the Cold and Moisture of the præcedent Night (whereby the Leaves were loaden towards the bottom, or in the bowle of the Flower, and so made to rise more upright and conjoyn their tops) and somewhat Exsiccating the Flower, make the pedestalls of its leaves more flaccid, so that they seem to expand and unfold themselves, and incline more outwards, meerly by reason of their want of strength to sustain themselves in an erect and concentrical posture: for alwayes the hotter the Day, the greater is the Expansion. Likewise, as

Art. 5. The Causes of the diurnal *Expansion*, and *Conversion* of the *Heliotrope* and other Flowers.

as for the Flowers *Conversion* to, or *Confronting* the Sun in all its progress above the horizon, wherein our Darksom Authors of Magick Natural, principally place the Magnale; the Cause thereof is so far from being more obscure than, that it is the very same with that of its Expansion. For, as the Sun running his race from East to West, doth every moment vary the points of his Rayes vertical incidence upon the stalk which supports the Flower, and upon the leaves thereof; so must the whole Flower incline its head and wheel about accordingly: those parts of the stalk upon which the rayes are more perpendicular, and so the heat more intense, becoming more dry and flaccid, and so less able to support the burthen of the Flower, than those, which suffer only from the oblique, reflected and weaker beams. Notwithstanding this Solution, if any Champion of secret *Magnetism* shall yet defend this *Circulation* to be a *Propriety* of the Heliotrope, to which no other Flower can prætend; and that this Solar Plant discovers it Amours to the Sun, by not only disclosing its rejoycing head and bosom at the præsence, and wrapping them up again in the mantle of its owne disconsolate and languishing leaves, during the absence of its Lover, but also by facing him all day long: lest He should insult, upon an apprehension, that our theory is at a loss, we shall tell him, in a word; that that *Propriety*, which he supposeth, must consist only in such a peculiar Contexture and Disposition of the particles, which compose its Leaves, as makes them more fit to receive, and be moved, and their spiritual and most subtle parts to be in a manner Circulated by the Rayes of the Sun, than the Leaves of any other Flower whatever. As in the Organ of Smelling, there is a certain Peculiar Contexture of its insensible Component Particles, which renders it alone capable of being moved and affected by Odours, that have no influence nor activity at all upon the Eye, Eare, or other Organ of Sense.

Art.6. Why Garden Claver hides it stalk, in the heat of the day.

(4) Great things have been spoken also of the *Garden Claver*, which *bareth its bosom, and hideth the upper part of its stalk, whenever the Sun shines hot and bright upon it*: but, this (doubtless) hath the same Cause, as the Former the Hiding of the stalk being nothing but an over-expansion of the Leaves, which by reason of the violent ardour of the Sun, grow more faint and flaccid, and so less able to support themselves.

Art.7. Why the *House Cock* usually *Crowes* soon after midnight; and at break of day.

(5) A Fifth Secret, found in the Catalogue of Cælestial Influxes, is the *Crowing of the House-Cock*, at certain and periodical times of night and day, and more especially soon after midnight, and about day break: for, most esteem it an Occult Propriety, and all our *Crollians* and such as promote the dreams of *Signatures* and *Sydereal Analogies*, reckon the Cock a cheif *Solar* Animal, for this reason alone; as if his Phansy received some magnetique touches and impressions from the Sun, which made him proclame his Advent into our Hemisphere, and like a faithful Watch or Clock, measure out the severall stages in its race. Great enquiry also hath been made after the *Cause* hereof, in all ages, and various Conceptions entertained concerning it. Some with lofty and Rhetorical Discourses endevouring to persuade, that Nature intended this Ὀρθριον ἀσμα, (as *Plutarch* calls it) or *Gallicinium*, as an Alarme to rouse up sluggish man from the dull armes of sleep, and summon him to the early Contemplation of her Works; as *Pliny* (*Natural. Histor. lib.* 10. *cap.* 21.)

Others

Others ascribing it to a Desire of Venery in this Animal, arising from the turgescence and stimulation of his sperm, at certain periods; as *Erasmus*, who is therefore worthily and sufficiently derided by *Scaliger* (*Exercit.* 239) Others assigning it to an Appetite of Aliment, invading and exciting after determinate intervalls; as *Cardan*. And others alleaging we (nor themselves) know not what peculiar influence of the Sun, causing a suddain mutation, or Evocation of the Spirits and blood of the Cock, which were Concentred by sleep; as *Cælius Rhodiginus* (*lib.* 16. *Antiq. Lection. cap.* 13.) But, All these Great Clerks seem to have grasp't the ear, and catched at shadowes. For (1) it may be doubted, that all Cocks, in one and some meridian, doe not Crow at the same times of night or day; and that no Cock doth observe set and punctual times of Crowing; both which are præsumed: and whoever shall think it worth the loss of a nights sleep, as we have done, to observe the Crowing of sundry Cocks in some Country Village, where the Houses stand scatteringly and far asunder, so that the Cocks cannot awake each other; will, perhaps, more than doubt of either. (2) It is, as Natural, so Familiar to the Cock, so often as his Imagination is moved by a copious and fresh afflux of Spirits to his Brain, to rowze up himself, clapp his wings, and sound his trumpet as well at noon, after noon, and at other times of day and night, upon several occasions; as when he hath escaped some late danger, obtained a victory, found some treasury of grain, compressed his mistress, and the like; as if his joy were not complete, till he had communicated the tidings thereof to his Wives and Neighbours, by the elevation of his gladsome and triumphat voice. (3) May we not allowe the Cock to have his set times of Sleeping and Waking, as well as all other Living Creatures, that live *suo jure*, and according to the Aphorisms of their Specifical Constitutions, and regiment of their proper Archæa's; and likewise most Men, who live healthfully and orderly, keeping to constant hours for labour, meat, rest and sleep? (4) What need is there that we should have recourse to such a far-fetcht (and never brought home) Cause, as that of a Secret Commerce, and peculiar Sympathy betwixt this Fowl and the Sun in the other Hemisphere; when we have a more probable and manifest one, neerer hand; *viz. The suddain invasion of the Cock, by encreased Cold soon after midnight?* For, when the Sun hath made some sensible advance in the lower world, beyond the Nadir point or midnight circle, and hasteneth toward our East; He moves and drives along before him into our horizon, the (formerly) quiet and cold Aer of the Night: which invading the Cock, disturbs him from his rest, during which his Heat is retired inward, and awakens him on the suddain: so that rowzing up himself, exciting his courage, and diffusing his Spirits again into his members, to oppose that Cold, and perhaps also to prevent his falling from the perch; he stands up, clappeth his wings against his sides, and chants a cheerfull Pæan to himself and Roost-fellowes, celebrating his safety and conquest with the loud musick of his throat.

Art. 8. Why *Shell-fish* growe *fat*, in the *Full* of the moon, and *lean* again at the *New*.

(6) A sixth notable Secret, appertaining to the same Classis, is that of the *Encrease of the Substance of Shell Fish, of the Brains in Coneys, and of the Marrow in the bones of most Land Animalls, as the moon approacheth her Full; and the Decrease of them again, as her Light decreaseth toward her New.* But, laying aside all Lunar Magnetism, Immaterial Influxes, and the like Toyes put into Great Words; we take it, the Phænomenon may be well enough solved, by referring it meerly to the *Moons great Humidity*; at least, if those vast Duskish spots, apparent in her Orb, be her moist Element, carrying some analogy to our Seas, as the most and best of our Modern Astronomers have believed, and upon grounds almost demonstrative, and wholly irrefutable. For, insomuch as the Rayes of the Sun, in greater abundance falling upon the face of the Moon, toward and at her Full, than in her Wane, are accordingly more abundantly reflected from thence upon our Terraqueous Globe, bringing along with them no sparing Tincture of the Moons Moisture; so that the Light which is Reflected from the Oceans in the moon, being more moist than warm, must needs be more Prolifical, Generative, and prædisposed to the Nutrition of Animals: and that in the New of the Moon no such plentiful Abduction of her moisture can be expected, because fewer of the Suns Rayes are, at that time, Reflected from her Orb to ours; why should it be thought so strange, that either Aquatile, or Terrestrial Animals should be nourished more plentifully at the Full, than New of the Moon? Especially since it is no præcarious, nor novell Assertion, that the Light coming from the Moon, is tincted with Humidity, as being reflected from the Watery as well as solid parts of her Orb; Experience having frequently demonstrated, that the Calorifick Rayes not only of the Sun, but even of our terrestrial and culinary Fires, being trajected through various Liquors, and other Catoptricall bodies, or reflected from them, doe imbibe and carry off much of their Virtues, and become thereby imprægnate, so as to be prædisposed to the production of sundry noble Effects, such specially as relate to the Alteration, Germination, Pullulation, and Generation of Vegetables and Animals, both Aquatile, and Terrestrial. Nevertheless, in case this Cause assigned seem somewhat Remote and obscure, we shall alleage *Another*, sufficiently verisimilous to ease men of their wonder, at the Fullness of the Shell Fish in the Full moon, and their Leaness in the New; and that is the *Encrease of the Tides of the Sea*, which ascending higher upon the shoars, at the Full moon, and washing down more of Mudd, Slime and Saltness from thence, afford greater plenty of Aliment to all Shell Fish: which delight in, and thrive best upon such kind of food, and are observed therefore to frequent foul and slimy shoars, and yet neerer and neerer to land, as the Tides rise higher and higher, and again remove farther and farther off, as the tides sink lower and lower.

Art. 9. Why the *Selenites* resembles the Moon in all her several Aspects.

(7) To this Classis also belongs the Famous *Selenites*, or *Moon-Gemme*, a certain præcious stone, found only in *Arabia*, as *Dioscorides* (*lib.* 5. *cap.* 110.) delivers: whose rare and singular Faculty is this, *that it repræsents the Moon in all her several Dresses of Light, or Apparences*, encreasing its Lustre exactly as she encreaseth hers, and proportionately losing it; if the Relations be true, which have been made thereof by Authors of the highest form for Credit, namely *Pliny* (*lib.* 36. *cap.* 10.) S. *Augustine*

gustin (*de Civit. D. lib.* 21. *cap.* 5.) *Zanardus* (*de Univers. Element. quæst.* 53.) *Nichol. Caussinus* (*lib.* 11. *Symbol.* 5[illegible].) *Joh. Daniel Mylius* (*Basilicæ Chymic. lib.* 5. *cap.* 28.) and many modern *Mineralogists*. Now, for the *Reason* of this Rarity, in all liklihood, it must be if not the very same, yet Cousin German to that of the former. Because, it is very probable, that some certain portion of a thin, fluid and subtle matter (we may conceive it to be Hydrargycal, or relating to Quicksilver, since all the forenamed Authors describe the stone to be White and Candent of Colour:) wherein the Lustre of the stone doth mostly consist, doth suffer some Alteration, according to the more and less of the Lunar Light incident upon it; and is respectively Circulated through the looser or less compacted parts of the stone, after the same manner as the more subtle and spiritual parts of some Flowers are Circulated by the rayes of the Sun; the particular Configuration and Contexture of its insensible particles being such, as dispose to that Circulation, upon the influx of the Moons Light.

Art. 10. Why the Consideration of the *Attraction of Iron by a Loadstone*, is here omitted.

In the Inventory of SPECIAL Sympathies and Antipathies, the First Division Concerns INANIMATE Natures; and among such the first place belongs to the *Attraction of Iron by the Loadstone*, the second to the *Attraction of Straws* and other small and light bodies by *Amber* and othe *Electriques*: but such is the singular Excellency of the *Former*, that it not only deserves, but challengeth a singular Chapter to its Disquisition; and the *Reason* of the *other* we have plainly, though succinctly explicated, in the precædent Section, the Consideration of the Wayes and Instruments of all Attraction Natural, in the General, impelling us upon the Anticipation thereof.

Art. 11. The secret Amities of *Gold* and *Quicksilver*, of *Brass* and *Silver*, unriddled.

In the *Third*, we are to examine the secret *Amity of Gold and Quicksilver, of Brass and Silver*; which is so manifest, that whenever Gold is dissolved in Chrysulca or *Aqua Regis*, and the Spirit or Dissolution of Quicksilver superadded thereto, the subtile Effluvia streaming from the particles of the Gold, will instantly lay hold of, and at distance attract and firmly embrace the particles of the Quicksilver, into which the Dissolving liquor hath subtiliated it; and in like manner, when Brass and Silver are dissolved in the same *Aqua Fortis*, their particles are observed to unite even to concorporation, though the Spirits issuing from them, are not potent enough to perform an Attraction, while the Metals remain entire and in the mass. These Effects we conceive may well be referred to the *Correspondency* or Compossibility betwixt the *Figures* of the insensible particles, of which the Emissions from the Gold, and Brass consist, and those of the *pores*, *inequalities*, and *fastnings* in the superfices of the Granules of the Dissolved Quicksilver, and Silver: but what those Figures are on each part, is above our hopes of determination; nor can we afford the Curious any other light for Conjecture in this true Abstrusity, but what himself may perceive to arise to him by Reflection from the Reasons, we shall hereafter give, for the Attraction of Iron by a Loadstone. In the mean while, we præsent Him, for Diversion of his Scrutiny, with a short and opportune COROLLARY.

Art. 12. A COROLLARY. Why the Granules of *Gold* and *Silver*, though much more ponderous then those of the *Aqua Regis* and *Aqua Fortis*, wherein they are dissolved, are yet held up, and kept floating by them.

Delightful it is, and indeed Admirable to behold the Granules of Gold and Silver, though much more ponderous than those of the *Aqua Regis*, and *Aqua Fortis*, to be notwithstanding held up, and constantly kept in a floating and elevated posture by them. And yet, in all likelihood the *Salt* dissolved in those Corrosive Waters, must be the Sole Cause of that strange Effect. For, the Salts which are plentifully dissolved in those Liquors, by a kind of mutual Cohæsion of their insensible particles supporting each other from the bottom to the top of the Glass, or other containing vessel; doe sustain and bear up the Granules of the Metals which they have Corroded and Embraced. And this seems the more probable from hence; that if common Water, imprægnate with a few dropps of Oyle of Tartar (that Great instrument of Separation) be superinfused upon those Tinctures, the Granules of the dissolved Metals suddainly disengage themselves from the arms of the Corroding Salts, and sink to the bottom: the fresh Water yet farther dissolving those Salts, and giving them fuller Fluidity; so that becoming more Attenuate, they lose their mutual Cohæsion, and so their power of supporting; and tis well known, that Salt water will beare up such bodies, as will hardly swim in fresh. And this we take to be the General Reason of all sorrs of Præcipitation, practised either by Chymists, or common Refiners of Metals: the Oyle of Tartar thereto conducing no otherwise, than meerly as it serves to the farther Attenuation of the Salt Armoniack and other Corrosive Salts formerly dissolved in the strong Waters.

Art. 13. The Cause of the *Attraction of a Less Flame by a Greater.*

(4) To the *Fourth*, we assign the *Attraction of a Less Flame by a Greater*; according to the erroneous Dialect of the People: for, really it is rather the *Extension of a Greater Flame to the Fewel of a Less.* For, the heat of a Greater Flame being proportionately more intense and diffusive, extends it self to the pabulum or nourishment of the less, where the same is situate within the Sphere of its power: and thence it comes to pass, that the Greater burning more strongly, by reason of that addition or augmentation of its fewel, doth more and more dilate it self that way, till at length it becomes wholly united to the Less. Which unexamining heads not understanding, have imputed to a certain Attractive faculty in the Greater Flame, depending upon the Identity of the two Natures, or more præcisely, the same Nature in two Divisions; and many have rackt their brains to erect subtle Discourses thereupon, as if they wanted other Opportunities to exercise their Learning, and entertain their Curiosity.

Art. 14. The Cause of the *Involation of flame* to *Naphtha*, at distance.

(5) To the *Fifth* belongs the supposed *Attraction of Flame by Naphtha* of *Babylon*, at distance; which is also improperly accounted an *Attraction*: for the Flame of its own accord flyeth to, and layeth hold of the Naphtha; and the Cause of that *Involation* is only this. From the body of the Naphtha there is emitted in round a certain fat and unctuous, and so soon inflammable Halitus, or steam, which being extended to the borders of some flame posited at convenient distance, and thereby kindled in the extreme of its Sphere, becomes enflamed all along the Rayes, and they burning, soon bring home the flame to the body of the Naphtha, from which they are emitted, in a continued fluor.

(6) Next

(6) Next to this, Philosophers usually place the *Attraction of Water by a Spunge*; wherein they are as much mistaken as in either of the two last. For, the Ascention of Water into the pores of a spunge, so placed as to touch only the superfice of it, comes not from any Appetite of Attraction, or Suction inhærent in the Spunge, as is generally præsumed and affirmed; but onely from the *Depression, or downward impulse of the water by the swelling and sensibly dilating spunge*; and the manner of that series of motions is thus. The skirts or lowest parts of the spunge, touching the superfice of the Water, immediately imbibe some parts of it into its pores, and becoming thereby dilated and tumid, press down the subjacent Water to such a proportion as responds to the quantity of their owne expansion; so that as they are more and more dilated by the admission of more and more parts of Water into their Cells or Receptaries, it must be, that the Water being more and more depressed toward the bottom, must rise higher and higher on the sides of the Spunge, and insinuate it self into other and other pores successively, till the whole spunge be filled. Manifest it is by Experience, that if Water or any other Liquor, when it is though never so gently pressed in the superfice, find any the smallest *Chinks* in the body pressing it; it doth instantly rise up in round, and insinuate it self into those pores or Chinks, the sides thereof in a manner sustaining it, and so præventing its relapse or efflux. This we cannot but observe, when we dip the nose of our Pen into ink; the small *Cleft* or slit in the lowest part of the Quill, assisting the Assent of the ink into the hollow thereof, and carrying up so much of it, as the mutual Coherence of its parts will permit: for, if we dipp the point of a Pen, which hath no slit, into a standish, we shall observe no such plentiful Assent of ink; there being no support or fastnings for it on each side of the nose, and so no obstacles to its relapse and sudden efflux. And, as for the Reason, Why *Water Ascends, when it meets with any body, that is Dry, Filamentous or Fibrous, and full of pores or Chinks, such as a Spunge, Cloth, Pen, &c.* it may be most fully explained by the Instance of a *Syphon*, or Pump.

Art. 15. Of the *Ascention* of Water into the pores of a *Spunge*.

Take a Pipe of Lead, of the figure of a Carpenters Squire, whose one arme is longer then the other (such our Wine Coopers exhaust their Buts of Wine withal) and immerse the shortest into a Cistern of Water, so as it may come very neer the bottom, and yet the longer arme rest upon the margin of the Cistern, in a dependent or declining posture, then with your mouth suck forth the Aer contained in the cavity of the pipe: and you shall observe the Water quickly to follow on the heels of the Aer, and flow in full stream out of the Cistern through the pipe, without ceasing till all the Water, that covers the shortest arme of the pipe, and so hinders the ingress of the aer into its orifice, be exhausted. Of this the *Cause* is only, that as your Cheeks are inflated and distended by the Aer, which upon exsuction comes rushing into your mouth, doe strongly move and impell the ambient aer; so doth that, receding, move and impell the neighbouring aer, and that again moves and impels the next, till the impulse be propagated to the surface of the Water in the Cistern: and the Water being thus depressed in the superfice, riseth up into the Cavity of the pipe, which the extracted Aer had newly deserted and left unpossessed; nor doth it thenceforth cease

Art. 16. The same illustrated by the example of a *Syphon*.

to ascend and flow in a continued stream through the pipe, until all be exhausted. Because, how much of Water flows through the pipe, exactly so much of Aer is, by impulsion, Circulated into the place thereof; the last round of aer wanting any other place to receive it, but what it provides for its self in the Cistern, by depressing the water yet remaining therein: and thus the Circulation once begun, is continued, till all the Water hath past through the pipe.

Art. 17. The reason of the *Percolation* of *Liquors*, by a *cloth* whose one end lieth in the liquor, and other hangs over the brim of the vessel, that contains it.

Upon the same Cause, or some other so like it, as tis no easie matter to discriminate them, doth that kind of *Percolation* of Liquors, and especially of *Aqua Calcis*, depend, which is made by a long piece of *Woollen Cloth*, whose one end lies in the Liquor, and other hangs over the brim of the vessel that contains it. For, the Liquor gently ascends and creeps along the filaments of the Cloth, because, being though but very lightly prest in it superfice by the same, it doth proportionately ascend in round, to deliver it self from that pressure; and by that motion impelling the incumbent Aer upwards, it causeth the same to Circulate and depress the surface of the Liquor, and so makes it rise by insensible degrees higher and higher along the hairs and threads of the Cloth, till at length it arrive at the highest part thereof resting upon the margin of the vessel; and thence it slides down the decline or propendent half of the Cloth, and falls down into the Recipient, by dropps. And this Motion is Continued till all the Liquor hath passed the Percolatory, leaving the fæces adhærent to the fibres of the same: each drop impelling the Ambient Aer, and driving it in round, or by a *Periosis*, upon the surface of the Water, so long as any remains in the vessel. And this, we conceive, may suffice to any mans Comprehension of the Reason of the Repletion of a Spunge, by Water *Ascending* (not Attracted) into its Cavities or Pores.

Art. 18. The reason of the *Consent* of *two Lutestrings*, that are *Æquisone*.

(7) Another eminent Secret of Sympathy, belonging to the same Division, is that *Consent betwixt two Lutestrings, that are Æquisone*: (for *Unisone* is hardly proper); which is thus experimented. Take 2 Lutes, or Vials, and their treble, mean, or base strings being tuned to an Equality of Sounds, lay one of them upon a table, with the strings upward, with a small short straw equilibrated upon the Æquison string: and then strike the Æquison string of the other instrument, and you shall observe, both by the leaping off of the straw, and the visible trembling of the string, whereon it was imposed, that it shall participate of the motions of the string of the other instrument percussed; all the other Dissonous strings, as wholly unconcerned in the motion impreſt, remaining unmoved. The like also will be, if the Diapason or Eighth to that string be percussed, either in the same Lute or Vial, or other lying by: but, in none of these, the Consent is discernable by any report of sound, but meerly by motion. And yet the Cause of this Sympathy is not so very obscure, but the dullest Pythagorean might soon have discovered it to be only this; that the percussed string doth suffer a certain number of Diadroms, or Vibrations, and impress the like determinate motions upon the Aer: which lighting upon another string of equal Contexture and Extension with the former percussed, doth impress the same motions thereupon, and impell and repell it so correspondently, as to make it suffer an equal number of

of Diadroms. Nor doth the Aer hinder it in its several Reciprocations or alternate excurses and recurses; because the percussed string makes all its alternate excurses and recurses, at and in the same time, as the untoucht string doth, and so impels the Aer alternately to the contrary side thereof. But, that agitated Aer which falls upon a string of a different degree of extension, and so necessarily of a different tone; though it impress various insensible strokes thereupon, yet are those impressed strokes such as mutually check and oppose each other, *i. e.* the Excurses hinder the Recurses: and therefore the string remains unmoved, at least as to the sense. Likewise, the Consent of another string, which makes that Consonance, which Musicians call a *Diapason* or *Eighth*, to that which is percussed by the hand, ariseth only from hence; that the Excurses and Recurses of the string percussed by the hand, do not at all clash with, nor perturb and confound the Excurses and Recurses of the string moved immediately only by the Aer, but are Coincident and Synchronical to them, and observe the same periods; and so both agree in their certain and frequent intervals: more particularly, in an Eight, every single Diadrom of the longer and more lax string, is coincident to every second, fourth, sixth, &c. Diadrom of the shorter or more tense string. Nay farther, if the two strings be Consonous though but in the less perfect Consonance of a *Fifth*; yet shall the sympathy hold, and manifest it self (which is not commonly observed) by the tremulation of the untouched string, that is tuned to a Fifth: because their Diadroms are not wholly confused, each single diadrom of the longer or lower string, being coincident to every third, sixth, ninth, &c. diadrom of the shorter or more tense string. But if the two strings be *Dissonous*, the sympathy fails; because the Excurses and Recurses agree not in any of their Intervals or Periods, but perturb and confound each other; as may be more fully understood from our præcedent Discourse of the *Reason of Consonances and Dissonances Musical.*

Art. 19. The reason of the *Discent* betwixt *Lute-strings of sheeps* Guts, and those of *Woolfs.*

(8) Nor is it the Inæquality of Tension, disparity of Longitude and Magnitude, or Non-coincidence of the Vibrations in their several periods, that alone make Two strings Discordant; for, if we admit the common tradition of Naturalists, where *an Instrument is strung with some strings made of Sheeps, and others of Woolfs Guts intermixed, the best hand in the World shall never make it yeeld a perfect Consonance, much less play an harmonious tune thereupon.* And the *Cause*, doubtless, is no other than this; that the strings made of a Woolfs Guts are of a *different Contexture* from those made of a Sheeps; so that however equally both are strained and adjusted, yet still shall the Aer be unequally percussed and impelled by them, and consequently the sounds created by one sort, confound and drown the sounds resulting from the other. To leave you in the less uncertainty concerning this, it is commonly observed, that from one and the same string, when it is not of an Uniforme Contexture throughout, but more close, even, and firme in some parts than in others (all such our Musicians call *False* strings) there doe alwayes result various and unequal sounds: the close, even and firm parts yeelding a smart and equal sound, the lax and uneven yeelding a dull, flat and harsh; which two different sounds at the same time created, confound and drown each other, and consequently where such a string is playd upon in Consort, it disturbs the whole Concent or Harmony. It is further observed also, that the Musick of an Harp doth

doth infect the musick of a Lute, and other softer and milder instruments with a kind of Asperity and Indistinction of Notes: which Asperity seems to arise from a certain kind of Tremor, peculiar only to the Chords of that Instrument. The like also hath been reported of other scarce Consortive Instruments, such as the Virginalls and Lute, the Welsh Harp and Irish, &c.

But you'll Object, perhaps, that the Discordance of Woolves and Sheeps Gutlings seemeth to arise rather from some Formal *Enmity*, or inhærent *Antipathy* betwixt the Woolf and Sheep: because it hath been affirmed by many of the Ancients, and questioned by very few of the Moderns, *that a Drum bottomed with a Woolfs skin, and headed with a Sheeps, will yeeld scarce any sound at all*; nay more, that a *Wolfs skin will in short time prey upon and consume a Sheeps skin*, if they be layed neer together. And against this we need no other Defense than a downright appeal to *Experience*, whether both those Traditions deserve not to be listed among Popular Errors; and as well the Promoters, as Authors of them to be exiled the society of Philosophers: these as Traitors to truth by the plotting of manifest falsehoods; those as Ideots, for beleiving and admiring such fopperies, as smell of nothing but the Fable; and lye open to the contradiction of an easy and cheap Experiment.

Art. 20. The tradition of the *Consuming of all Feathers of Foul, by those of the Eagle*; exploded.

(9) Nor can we put a greater value upon the *Devouring of all other Birds Feathers by those of the Eagle commixt with them*; though the Author of *Trinum Magicum* hath bin pleased to tell us a very formall and confident story thereof: because we have no Reason to convince us, that the Eagle preys upon other Fowls, out of an Antipathy or Hatred, but rather out of Love and Convenience of Aliment; and though there were an Enmity betwixt the Eagle and all his feathered subjects, during life, yet is there no necessity that Enmity should survive in the scattered peices of his Carcass, especially in the Feathers (that are but one degree on this side Excrements) which is præsumed to consist cheifly in the Forme; since those Proprieties which are Formal, in Animals, must of necessity vanish upon the destruction of the Forme, from whence they result. Thus Glow-worms project no lustre after death; and the Torpedo, which stupefies at distance, while alive, produceth no such effect though topically applied, after death: for there are many Actions of Sensible Creatures, that are mixt, and depend upon their vital form, as well as that of mistion: and though they seem to retain unto the Body, doe yet immediately depart upon its Disunion.

Art. 21. Why some certain *Plants* befriend, and advance the growth and fruitfulness of others, that are their neighbours.

In the SECOND Division of *Special* Occult Qualities, *viz.* such as are imputed to *Vegetables*, the First that expects our Consideration, is the so frequently mentioned and generally conceded *Sympathy, or mutually beneficial Friendship betwixt some certain Plants*, as betwixt *Rew*, and the *Figg-tree*, the *Rose* and *Garlick*, the *Wild Poppy* and *Wheat*; all which are observed to delight and flourish most in the neighbourhood of each other, and our skilful Gardners use to advance the growth and fructification of the one, by planting its favourite neer it. Concerning this, therefore, we advertise; that men are mistaken not only in the Cause, but Denomination

Denomination alſo of this Effect: ſuppóſing a ſecret Friendſhip where is none, and imputing that to a certain Cognation, or Sympathy, which ſeems to proceed from a manifeſt Diſſimilitude and Antipathy betwixt Divers Natures. For, wherever two Plants are ſet together, whereof the one, as being of a far Different, if not quite Contrary Nature, and ſo requiring a different kind of nouriſhment, doth ſubſtract and aſſimilate to its ſelf ſuch a juice of the earth, as would otherwiſe flow to the other, and deprave its nouriſhment, and conſequently give an evil tincture to its Fruit and Flowers: in this caſe, Both Plants are reciprocally the remote Cauſe of the Proſperity each of other. And thus Rew, growing neer the roots of the Figg-tree, and attracting to its ſelf the Rank and Bitter moiſture of the earth, as moſt agreeable to its owne nature; leaveth the Milder and Sweeter for the aliment of the Fig tree, and by that means both aſſiſteth the procerity of the Tree, and Melioratetb the Fruit thereof. Thus alſo Garlick, ſet neer to a Roſe tree, by conſuming the Fœtid juice of the ground, and leaving the more Odorate and benigne to paſs into the roots of the Roſe tree; doth both farther the Growth and Germination thereof, and encreaſe the Sweetneſs of it Flowers. But, as for the Amity betwixt the *Wild Poppy* and Wheat, we ſhould refer it to another Cauſe, *viz.* the Qualification of the ground by the tincture of the Wheat, ſo as to præpare it for the Generation and growth of the Wild Poppy; not by ſubſtraction of Diſagreeing moiſture, but by Enriching the Soyle, or impræg-nating it with a ferility, determinate to the production of ſome ſorts of weeds, and chiefly of that. For, moſt certain it is, that there are certain Corn-flowers, which ſeldom or never ſpring up but amongſt Corn, and will hardly thrive, though carefully and ſeaſonably ſet in other places: ſuch are the Blew-bottle, a kind of yellow ſingle Marygold, and the Wild-Poppy.

Art. 22. Why ſome Plants thrive not in the ſociety of ſome others.

(2) This diſcovered, we need not ſearch far after the Reaſons of thoſe *Antipathies*, which are reported to be between the *Vine* and *Cole-woort*, the *Oke* and *Olive*, the *Brake* and *Reed*, *Hemlock* and *Rew*, the Shrub called our *Ladies Seal* (a certain Species of Bryony) and the *Cole-woort*, &c. which are preſumed to be ſo odious each to other, from ſome ſecret Contrariety of their reſpective Forms, that if any two of them, that are Enemies, be ſet neer together, one or both will die. For, the truth is, all Plants, that are great Deprædators of the moiſture of the earth, defraud others that grow neer them, of their requiſite nouriſhment, and ſo by degrees impoveriſhing, at length deſtroy them. So the Colewoort, is an enemy not only to the Vine, but any other Plant dwelling neer it; becauſe it is a very ſucculent and rank Plant, and ſo exhauſts the fatteſt and moſt prolifical juice of the ground. And if it be true, that the Vine will avoid the Society of the Colewoort, by Averting its trunck and branches from it; this may well be only in reſpect of its finding leſs nouriſhment on that ſide: for, as the *Lord St. Alban* hath well obſerved, though the root continue ſtill in the ſame place and poſition, yet will the Trunk alwayes bend to that ſide, on which it nouriſheth moſt. So likewiſe the Oke and Olive, being large trees of many roots, and great ſpenders of moiſture, doe never thrive well together: becauſe, the ſtronger in Attraction of juice, deceives and ſtarves the weaker. Thus Hemlock is a dangerous neighbour to Rew; becauſe, being the Ranker Plant of the two, and living upon the like juice, it defrauds it of ſufficient

ſuſtenance,

ſuſtenance, and makes it pine away for penury. And the like of the reſt.

Art. 23. The Reaſon of the great Friendſhip betwixt the *Male* and *Female* Palm-trees.

(3) But what ſhall we think of that ſemiconjugall *Alliance betwixt the Male and Female Palme trees*, which is ſo ſtrong and manifeſt, that the Femal, which otherwiſe would languiſh, as if ſhe had the Green ſickneſs, and continue barren; is obſerved to proſper, and load her fruitful boughs, with braces of Dates; when ſhe enjoys the Society of the Male: nay, to extend her arms to meet his embraces, as if his maſculine influence were neceſſary not only to her impregnation, and the maturity of her numerous iſſue; but even to her own health and welfare? Why, truly, we cannot better expound this dark Riddle of Nature, than by having recourſe to ſome *Corporeal Emanations*, deradiated from the male; which is the ſtronger and more ſpriteful plant, to the Female, which is the weaker, and wants an Acceſſion of heat and ſpirits. For, far enough from improbable it is, that ſuch Emanation may contain much of the Males *Seminal* and *fructifying virtue*; and it hath been avouched by frequent Experiments, that the bloſſoms and Flowers of the Male being dried and poudered, and inſperſed upon the branches of the Female, are no leſs effectual to her Comfort and Fertility, than the Vicinity of the Male himſelf. We are told, indeed, by *Herodotus*, and from his own ſtrict obſervation; that the Male Palm produceth yearly a Dwarfiſh ſort of Dates, which being uncapable of maturity and perfection, men uſe therefore to gather early, and bind them on the loaden branches of the Female: that there corrupting, and breeding a kind of ſmall volant Inſect, reſembling our Gnats (which the Natives call *Pſene*, though *Theophraſtus* ſeems to appropriate that name only to thoſe Flyes, that are a ſpontaneous production out of the immature fruit of the Wilde Figg tree, ſuffering putrefaction) that they may advance the Growth and Maturity of her fruit; not by any ſecret influence, but the manifeſt Voracity of thoſe Inſects, which continually preying upon the ripening fruit, both open the tops of them, and ſo make way for the rayes of the Sun to enter more freely and deeply into their ſubſtance, and ſuck out moſt of the luxuriant crude and watery juice, leaving the Alimentary and Unctuous to the more eaſie digeſtion and aſſimilation of the formerly overcharged Seminal Virtue of the Plant This, we confeſs, is nice and plauſible, but not totally ſatisfactory; becauſe it extends only to the Reaſon of the Males remote Aſſiſtance of the Female, in the maturation of her Fruit; leaving us ſtill to enquire, Why ſhe herſelf remains in a ſteril and pining condition, unleſs ſhe enjoys the Society and invigorating irradiation of the Male; and why ſhe inclines her amorous boughs toward his, as if meer Neighbourhood were a kind of Divorce, and nothing leſs than abſolute Union could ſatisfie her Affection. And what we have here ſaid, of the Sympathy betwixt the Male and Female Palms, will not loſe a grain of its Veriſimility, when our Reader ſhall pleaſe to accommodate it to the Explanation of the Cauſe of the like Amity betwixt the *Fig tree*, and *Caprificus* or *Wild Fig tree*: of which *Pliny* (*lib.* 15. *cap.* 19.) relates the very ſame ſtory, as *Herodotus* doth of the Palms.

(4) This

(4) This puts us in mind of the great Sympathy betwixt *Vine* and *Wine*, expressed from its Grapes, and immured in Hoggheads, though at the distance of many miles. For, it seems most convenient, that it is from the like *Diffusion of subtle Emanations*, imbued with the *Seminal tincture* of the Vine, that Wines stored up in deep Cellars, in the same Country where they grew (for, in *England*, whither all wines are transported over sea, no such Effect hath been observed: the Remove being too large to admit any such Transmission of influence from the transmarine Vineyards to our Cellars) become sick, turbid, and musty in the Cask, at the same time the Vines Flower and Bud forth: and again recover their former Clearness and Spirit, so soon as that season is past. And, that this Conjecture may seem to smell the less of Phansy, we desire you to consider, through what large tracts of Aer even the *Odours* (Exhalations much less Subtile and Diffusive, than those we conceive emitted from Vines to Wines) of many Aromaticks are usually diffused, in serene weather; especially in respect of such Persons, and Bruit Animals, as are exquisite in their sense of smelling. Hath it not been observed, that the Flowers of Oranges have transmitted their odours perfect and strong, from great Gardens, to the nostrils of Mariners, many leagues off at Sea: nay, so far, that some Sailers have discovered land by the smell of them, when their longest Perspectives could not reach it? Doe not we frequently observe, that Ravens will scent a Carcass, at many miles distance; and fly directly to it by the Chart of a favourable wind? Nay, are not there good Historians that assure us, that Eagles in *Italy*, have sometime received an invitation by the nose, to come and feast on the dead bodies of men, in *Africa?*

Art. 24. Why all wines grow sick and turbid, during the season wherein the *Vines Flower*, and *Bud*.

Here, since we are occasionally fallen upon the large Diffusion of some Odours, especially to sage and unpræpossessed Noses; we shall take the advantage of that Hint, to advertise you of a *Vulgar Error*, viz. *that Waters distilled of Orange Flowers and Roses, become wholly Inodorous, and Phlegmatick, at the time of the Blooming and Pride of those Flowers upon their trees.* For, really those distilled Waters are not in themselves, during the season of the Flowers, from which they were extracted, less fragrant than at other times: but, because in the season of those Flowers, they diffuse their odours so plentifully through the Aer, and præpossess the nostrils, as that the odours of the Waters, being somewhat less quick and strong, are less perceived, than at other times, when the Aer is not imbued with the stronger and fresher odours, nor the olfactory Nerves præoccupied. And this may be inferred from hence; that when the season of those Flowers is past, and the smelling organ unoccupied; the Waters smell as fragrant as ever. For, as to the *Assuefaction* of the sense of smelling, to particular odours, good or bad, we need not say much of that: since Experience doth daily confirme, that the sense is scarce moved and affected by the same odour, though closely præsented, after Custom hath once strongly imbued it with the same.

Art. 25. That the distilled waters of *Orange flowers*, and *Roses*, doe not take any thing of their fragrancy, during the season of the Blooming and pride of those Flowers; as is vulgarly believed.

Sect. III.

Art. 1. Why this *Section* considers only some *few* select Occult Proprieties, among those many imputed to *Animals*.

IN the THIRD and last Division of *Special* Occult Qualities, or such as are vulgarly imputed to *Sensible* Creatures; the Pens of Schollars have been so profuse, that should we but recount, and with all possible succinctness, enquire into the Verity and Causes of but the one Half of them; our Discourses would take up more sheets of Paper, than are allowed to the Longest Chancery Bill: wherefore, as in the former, so in this, we shall select and examine only a Few of them, but such as are most in vogue, and whose Reasons, if judiciously accommodated, suffice to the Solution of the Rest.

Art. 2. The supposed *Antipathy* of a *Sheep* to a *Woolf*, solved.

(1) The *Antipathy of a Sheep to a Woolf*, is the common argument of wonder; and nothing is more frequent, than to hear men ascribe it to a provident Instinct, or hæreditary and invincible Hatred, that a Lamb, which never saw a Woolf before, and so could not retain the impression of any harme done or attempted by him, should be invaded with horror and trembling, at first interview, and run from him: nay, some have magnified the secret so far, as to affirme the Antipathy to be Equall on both sides. Concerning this, therefore, we observe; that the Enmity is not Reciprocal: For, He that can be persuaded, that the Woolf hates the Sheep, only because he worries and preys upon him, and not rather, that the Woolf loves the sheep, because it is a weak and helpless Animal, and its flesh is both pleasant and convenient food for him: we shall not despair to persuade Him, that Himself also hates a sheep, because he finds his pallate and stomach delighted and relieved with Mutton. Nor is the Enmity on the sheeps side Invincible; for, ourselves have seen a Lamb brought, by Custom, to so great familiarity with a Woolf, that He would play with him, and bleat, as after the Dam, when the Woolf hath removed out of the room: and the like Kindness have we very lately observed betwixt a Lamb and Lyon of the Lord Generall *Cromwells*, kept at *Sion* house, and afterward publikely shewed in *London*. Again, the Fear, which surpriseth the Lamb at first sight of a Woolf, seems not to arise from any Hereditary Impression derived from the Dam, or Sire, or Both; as well because all Inbredd or traduced Antipathies are invincible, as that none of the Progenitors of the Lamb, for many Ages, ever saw or received any impression of injury from a Woolf, here with us in *England*. Besides, in case they had, and though it be indisputable, that some Beasts are afraid of men, and other Beasts, meerly from the memory of some Harme received from some man, or Beast of the same species; the Idea of him, that did the Harme, remaining impressed upon the table of the Memory, and being freshly brought again to the Phansy, whenever the sense brings in the like species: yet is it not likely, that the same Idea should be propagated by Generation to the issue, after so many hundred removes, and traduced from one Individual to the whole species, throughout the world.

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The Cause, therefore, why All Sheep generally are startled and offended at sight of a Woolf, seems to be only this; that when the Woolf converts his eyes upon a sheep, as a pleasing and inviting object, and that whereupon Appetite hath wholly engaged his Imagination; he instantly darts forth from his brain certain streams of subtle Effluvia's, which being part of those Spirits, whereof his newly formed Idea of dilaniating and devouring the sheep, is composed, serve as Forerunners or Messengers of destruction to the sheep; and being transmitted to his Common Sensory, through his optick nerves, most highly misaffect the same, and so cause the sheep to fear, and endeavour the præservation of his life, by flight.

Art. 3. Why *Bees* usually invade *Froward* and *Cholerick* Persons: and why *bold* and *confident* men have sometimes daunted and put to flight, *Lyons* and other ravenous Wild Beasts.

This receives sufficient Confirmation from hence; that not only such Aversions, as arise from the Contrariety of Constitutions in several Animals, are commonly observed to produce those Effects of Fear, Trembling and flight from the objects, from which offensive impressions are derived, by the mediation of disagreeing Spirits or Emanations: but even the seeing them in a passion of Anger, or Fury, doth suddainly cause the like. For, violent Passions ever alter the Spirits, and Characterize them with the idea at that time most prævalent in the Imagination of the Passionate; so that those spirits issuing from the body of the Animal, in that height of Passion, and insinuating themselves into the brain of the other Animal contrarily disposed, must of necessity highly disgust and offend it. Which is the most likely Reason that hath hitherto been given, Why *Bees* seldom sting men of a mild and peaceful disposition: but will by no means endure, nor be reconciled to others of a froward, cholerick, and waspish nature. The same also may serve to answer that common Quære, Why some *Bold and Confident* persons, having tuned their spirits to the highest key of Anger and Indignation, have *daunted* not only fierce *Mastiffs*, but even *Lyons*, *Panthers*, and other Wild and ravenous Beasts, meerly by their threatning looks, and put them to flight by the Artillery of their scornful Eyes. And this Key, wherewith we have unlockt the secret betwixt the Lamb and Woolf, will also open those like Antipathies supposed to be betwixt the *Dove* and *Falcon*, the *Chicken* and *Kite*, and all other weak Animals, and such as use to make them their prey.

Art. 4. Why divers Animals *Hate* such men, as are used to destroy those of their owe species: and why Vermin avoid such Gins and Traps, wherein others of their kind have been caught and destroyed.

(2) It is worthy a serious Remark, that *sundry Animalls bear a kind of implacable Hatred to the Persons of such men, as are delighted or conversant in the Destruction of those of the same species with them*: as we daily see, that swine are highly offended and angry at Butchers: that Dogs bark at and pursue Glovers, that deal most in Dog skins, and Beadles that are imployed in killing of Dogs, in time of the plague, to prævent the diffusion of Contagion, and encrease of Putrefaction, by their means; that Vermin will avoid the trapps and gins of Warrenners, wherein any of their owne kind hath been taken and destroyed, &c. As for these Antipathies, or strong Aversions, tis manifest, that they arise not from any Specifical Instinct, or Character of Providence impressed upon their respective Natures, or Essential Forms, but only from the Activity of the præsent object upon the sense. For the Blood commonly adhæring to the cloths of the Butcher, and Dogg-killer, and likewise to the traps and gins, wherein Vergin have been caught and destroyed; doth emitt such odours, as invading the Sensory of any

any Animal of the same species, excite a kind of Horror in the like Animal that smells them; and so cause it to abhor and avoid all such persons and places, for fear of the like harm and internecion, as their fellowes have suffered from them. Now, that which makes these odours insinuate themselves with such ease and familiarity into theSensories of animals of the same species, is the similitude and Uniformity of their Specifical Constitutions, which yet the rough hand of Corruption seems not totally to have obliterated in the long since extravenated blood and spirits, but to have left some Vestigia or Remains of the Canine nature in the Doggs blood, of the Porcine in the Swines, &c. And, that which makes them so horridly *Odious*, is the great Alienation of the blood from its genuine temper and conditions. For, the smell of the Carcass, or blood of any Animal, having once suffered the Depravation of Corruption; is always most hateful and dangerous to others of the same Species: and it hath been observed, that the most pernicious Infections and Plagues have been such, as took their Original from the Corruption of Humane Bodies; which indeed, is the best reason that hath been yet given, why the Plague so often attends long and bloody Sieges, and is commonly the second to the Sword. We conceive, the same to be also the ground of that Axiom of the *Lord St. Alban* (*Nat. Hist. cent.* 10.) *Generally, that which is Dead, or Corrupted, or Excerned, hath Antipathy with the same thing, when it is Alive, and when it is sound; and with those parts which do excern: as a Carcass of Man is most infectious and odious to man, a Carrion of an Horse to an Horse, &c. Purulent matter of Wounds and Ulcers, Carbuncles, Pocks, Scabbs, Leprousy, to Sound flesh. And the Excrements of every species to that Creature, that excerneth them. But the Excrements are less Pernicious, than the Corruptions.*

Art. 5. The Cause of the fresh *Cruentation* of the Carcass of a murthered man, at the præsence and touch of the *Homicide.*

(3) The *Cruentation* (and, according to some reports, *the opening of the Eyes*) *of the Carcass of a murthered man, at the præsence and touch of the Homicide*; is, in truth, the noblest of Antipathies: and scarce any Writer of the Secrets or Miracles of Nature, hath omitted the Consideration thereof. This Life in Death, Revenge of the Grave, or loud language of silent Corruption, many Venerable and Christian Philosophers have accounted wholly *Miraculous* or *Supernatural*; as ordained and effected by the just judgement of God, for the detection and punishment of the inhumane Assassine. And, lest we should seem too forward, to expunge, from the mind of any man, the beleif of that opinion, which to some may be a more powerful Argument, than the express Command of God, to deterr them from committing so horrid and execrable a Crime as Murder: we shall so far concurr with them, as to conceive this Effect to be *Divine* only in the *Institution*, but meerly *Natural* in the *Production*, or *Immediate* Causes. Because the Apparence seems not to transcend the Capacity of Natural Means, and the whole Syndrome and Series of it Causes may be thus explained. It is an Opinion highly Consentaneous, that in every vehement Passion there is formed a certain Idea as well of the Object, whereupon the Imagination is most intent, as of the Good or Evil connected unto, and expected from that Object; and that this Idea is as it were impressed, by a kind of inexplicable Sigillation; upon the Spirits, at the same instant the Mind determineth to Will the præsent Prosecution, or Avoidance of the object: So that, by the mediation of the Spirits (those Angels of the

the Mind) the same Idea is transmitted to the Blood, and through the Arteries diffused into all parts of the body, as well as into the Nerves and Muscles, which are inservient to such Voluntary Motions, as are requisite to the execution of the Decrees and Mandats of the Will, concerning the Prosecution, or Avoidance of the Object. This being so, we may conceive, that the Phansy of the Person assaulted by an Assassine, having formed an Idea of Hatred, Opposition, and Revenge, and the same being Characterized upon the Spirits, and by them diffused through the blood; though the blood become much less Fluid in the veins after death, by reason the vital influence and Pulsifick Faculty of the Heart, which Animated and Circulated it, is extinct: yet, because at the præsence of the Murderer, there issue from the pores of his body such subtile Emanations, as are Consimilar to those, which were emitted from him, at the time He strove with, overcame, and killed the Patient; and those Emanations entering the Dead Body, doe cause a fresh Commotion in the blood remaining yet somewhat Fluid in its veins, and as it were renew the former Colluctation or Duell betwixt the yet wholly uncondensed Spirits of the slain, and those of the Homicide: therefore is it, that the Blood, suffering an Estuation, flows up and down in the veins, to seek some vent, or salley-port; and finding none so open as in that part, wherein the wound was made, it issues forth from thence. And, where the Murthered Person is destroyed by strangulation, suffocation, or the like unbloody Death, so that there is no manifest Solution of Continuity in the skin, or other Exterior parts of the body; in that case, it hath been observed, that the Carcass bleeds at the Mouth, or Nose, or both; and this only because in all vehement strivings, and especially in Colluctation for life, the Spirits and Blood flow most plentifully into the Arteries and Veins of the Head, as is visible by the great Redness of the Eyes and face of every man that Fights; and where the blood fixeth in most plenty, there will be the greatest tumult, æstuation and commotion, when it is fermented, agitated, and again set afloat, by the Discordant Effluvia's emitted from the body of the neer approaching or touching Murtherer. and consequently, there must the vessels suffer the greatest stress, distension, and disruption, or apertion of their orifices.

Art. 6. How the *Basilisk* doth empoyson and destroy, at distance.

(4) And this magnale of the (as it were) Reanimation of the vindictive blood in the veins of a Dead body, by the Magick of those Hostile and Fermenting Aporrhæa's, transmitted from the body of Him, who violently extinguished its former life; ushers in Another, no less prodigious, nor less celebrated by Naturalists: and that is the sudden *Disanimation of the Blood in Living Bodies, by the meer præsence of the Basilisk, Catablepa, and Diginus*; Serpents of a Nature so transcendently Venemous, that, according to popular Tradition, and the several relations of *Dioscorides*, *Galen*, *Pliny*, *Solinus*, *Ælian*, *Avicen*, and most other Authors, who have treated of the Proprieties of Animals and Venoms, they are Destructive beyond themselves, i.e. *they either kill by intuition, or Hiss out the flames of life by their Deleterious Expirations.* If Natural Historians have herein escaped that itch of Fiction, to which they are so generally subject, when they come to handle Rarities; and that Nature hath produced any such Species, whose optical Emissions, or Pectoral Expirations are fatal and pernicious

nicious to all, or most other Living Creatures; neither of which seems to be above Controversie: the *Cause* of this stupendious Effect must consist only in this, that those Rayes which are emitted from the Eyes, or that Halitus expired from the Lungs (for, their Hissing is far more loud and vehement than that of any others) of these Serpents, are Deleterious in the superlative degree, *i. e.* of such *Subtlety* and *Vehemence*, that they no sooner invade an Animal, but they as it were in a moment alter and subvert the requisite temper of that spiritual substance, wherein its life doth proximly and principally depend, and so render it theneforth wholly unfit to performe the Actions of Life. But, as for those other Traditions (1) of the Basilisks destroying a man by prior Aspect alone (2) of its Identity with the Cockatrice, which hath no real existence in Nature, and is only an Hieroglyphical Fiction, or Symbolical Invention of the old Ægyptians (3) of its Production from the Egg of an old decrepite Cock; and (4) of its being an Animal with wings, legs, a long and spiral Taile, and a Crist or Comb on the head, like that of a Cock, as it is vulgarly described and painted, and repræsented in those artificial contrivances made of the skin of a Thornback, by Impostors: we may justly refer them partly to absolute Impossibilities, partly to vain and ridiculous Follies; as the industrious *Aldrovand*, and ingenious Doctor *Brown* have done before us.

Art 7. That the sight of a Woolf doth not cause *Hoarsness* and *obmutescence* in the *spectator*; as is vulgarly reported and believed.

(5) The Rarity of the Basilisk, coming not much behind that of the Phenix (for, we have not heard of more than four or five, in the space 2000 years) may, we confess, somewhat excuse the Credulity of those, who have so easily swallowed the Figment of it poysoning a man by Priority of Aspect alone; because to the Refutation of it by Experiment, it is requisite that the Opponent live at the same time, and in the same Country, with that King of Venoms. But, we doe not see, what extenuating plea can remain to those soft and flexible minds, that so readily assent to that common Tradition, that *the sight of a Woolf affects the Specator with absolute Dumbness, or very great Hoarsness, at least:* when there are few Countries, but have Woolves enough to give any Enquirer the opportunity of Experiment; and Few of those, who have encountred Woolves very often, and that in woods and deserts, have been heard to complain of any Symptome or Mis-affection thereupon. Which is evidence sufficient, that either the Antipathy of man to a Woolf was the Dream of some vain and Romantique Phansy; or, that men have deluded themselves, by the heedless Consignation of the Effect to a remote and unconcerned Cause, blindly ascribing that to some specifical Hostility betwixt the insensible Emanations transmitted from the Eyes of the Woolf, and the temperament of the Tongue and other organs of speech in man, which, in truth, belongs only to the Passion of Fear, wherewith any pusillanimous or cowardly Person may be strongly surprized, at the suddain and unexpected sight of a Woolf. For, manifest it is (1) that whoever fears not a Woolf, shall never find any such Palsy in his tongue, or Asperity in his throat and vocal Artery, at the sight of him: as the daily Experience of such, in *Ireland* and other Countreys, frequently infested with Woolves, as delight in Hunting them, doth demonstrate. And (2) that whoever Fears, shall find in himself the same symptome of obmutescence, or difficulty of Vocifer-

ration,

ration, whether he sees the Woolf first, or the Woolf him; suddain silence being ever the Associate, or (rather) Consequent of great and suddain Fear. The Aphonia, therefore, or Defect of voice, which hath sometimes, though very rarely, been observed to invade men, upon the Conspection of Woolves; is not the genuine Effect of any secret and radicated Antipathy, or Fascinating Virtue in the subtle Aporrhæa's emitted from the eyes, lungs, or bodie of the Woolf: but only of their own *Fear* and *Terror*, arising from a strong apprehension of Danger; the suddain and impetuous Concentration of the Spirits, toward the Heart, by reason of the violent Terror, at that time, causing a Defection of spirits, and consequently a kind of Relaxation in the Muscles of the Tongue, and Nerves inservient to the vocal instruments: So that the inspired Aer cannot be Efflated with that force and celerity, as is necessary to the loudness and distinct articulation of the voice.

Art. 8. The *Antipathies* of a *Lyon* and *Cock*; of an *Elephant* and *Swine* meerly Fabulous.

(6) Nor is it the Eye alone, that the Folly of men hath made obnoxious to Antipathies, but the Ear also hath it share of wonderful Effects; for, there go solemn stories of inveterate and specifical Enmities betwixt the *Lyon and Cock, Elephant and Swine*, and He hath read little, who hath not more than once met with sundry relations, that *the Crowing of the Cock is more terrible than death, to the fiercest Lyon, and the Grunting of a Swine so odious to an Elephant, that it puts him into an Agony of Horror, Trembling, and Cold sweat.* Which notwithstanding, may well be called to the barre of Experiment, and many worthy Authors have more then questioned, among whom, *Camerarius* (*in Symbol.*) expresly assures us, that in his time, one of the Duke of *Bavaria*'s Lyons, breaking into a yard adjacent to his Den, and there finding a flock of Poultry, was so far from being afraid of the Cock, or his Crowing, that he devoured him and his troop of Hens together. And as for the *other* Antipathy; ourselves have seen an Elephant feed and sleep quietly in the same stable, with a Sow and her whole litter of Piggs. However, lest some should plead the power of *Custom*, in both these cases, and object, that that Lyon and Elephant had been, by *Assuefaction*, brought to endure the naturally hateful Noises of the Cocks Crowing, and the Swines Grunting; to eradicate the belief of the supposed Occult Antipathies, we say: that such may be the Discrepancy or Disproportion betwixt the Figures and Contextures of those subtile particles, that compose those Harsh Sounds, and the Contexture of the organs of Hearing in the Lyon and Elephant, as that they exasperate them, and so highly offend those Animals. For, thus we suffer a kind of short Horror, and our Teeth are set on edge, by those harsh and vehement sounds, made by scraping of trenchers, filing the teeth of saws, squeaking of doors, and the like: only because those sounds grate and exasperate the Auditory Nerves, which communicate the harsh impression to the Nerves of the Teeth, and cause a stridor therein.

Art. 9. Why a man intoxicated by the venome of a *Tarantula*, falleth into violent fits of *Dancing*; and cannot be cured by any other means, but *Musick*.

(7) But if we pass from these Imaginary, to *Real* Antipathies, and desire not to misimploy our Understanding, in the quest of *Dihoties* for such things, of whose *Hoti* the more sober and judicious part of Schollars justly doubt; let us come to the wonderful Venome of the TARANTULA, a certain Phalangium or smal Spider frequent in *Italy*, but most in and about *Tarentum* in *Apulia*; which hath this strange Propriety, that being

ing communicated to the bodie of man, by biting, it makes him Dance most violently, at the same time, every year, till He be perfectly cured thereby, being invincible by any other Antidote but Musick. An Effect so truly admirable, and singular, that the Discovery of its abstruse Causes, and the manner of their operation, cannot but be most opportune and grateful to the Curious; who, we presume, would gladly knowe,

Why such as are empoysoned by the biting of a Tarantula, fall into violent Fits of Dancing, and cannot be Cured by any other Remedies, but the Harmonious Straines of Musick alone?

SOLUTION.

How great the power of Musick is, as to the excitement, exaltation, and compescence or mitigation of the Passions of the Mind of Man; and wherein the Cause of that Harmonical Magick doth consist: would be a Digression, and perhaps somewhat superfluous for us here to enquire. And, therefore, cutting off all Collateral Curiosities, we shall confine our present scrutiny to the limits of our owne Profession; endeavouring only to explain the Reasons, why Musick hath so strong and generous an Energy, as certainly to cure the Bodie of a man, intoxicated with the Venome of the Taruntula, which eludes and despises the opposition of all other Alexipharmacal Medicaments. Forasmuch, therefore, as the strings of a Lute, Vial, or other Musical Instrument, do alwayes move and impell the Aer, after the same manner as themselves are moved and impelled, and by this proportionate misture of Sounds create an Harmony delightful not only to the Eare, but to that Harmonious Essence, the soul, which Animates the Eare; hence comes it, that by the musical Harmony, that is made by the Musicians playing to the person infected with the Tarantisme, the Aer, by reason of the various and yet proportionate motions of the strings, is harmonically moved and agitated, and carying those various motions of the harmony impressed upon it self, into the Eare, and so affecting the Phantastical Faculty with those pleasant motions, doth in like manner affect and move the spirits in the brain: and the spirits having received those impressions, and diffused into the Nerves, Muscles and Fibres of the whole body, and there meeting with a certain thin, acrimonious and pricking Humor, which is the chief fewel and vehicle of the Venome derived from the Tarantula; they attenuate and agitate the same, by a way very like that of Fermentation, and disperse it with a quick motion through all the parts. And this Humor being thus set afloat, and estuated, together with the venome, or seeds of the Poyson, which are contained therein, must needs affect all the Musculousand Nervous parts, upon which it toucheth, with a kind of Itch, or gentle and therefore pleasant vellication, or (rather) Titillation: So that the Patient feeling this universal Itch, or Tickling, can be no longer at ease and quiet, but is compelled thereby to dance and move all the members of his body with all agility and violence possible. This Dancing causeth a Commotion of all the Humors in his body; that Commotion augments the present Heat thereof; that Heat causeth a Relaxation and Apertion of the pores of the skin; and thereupon ensues a liberal and universal sweat;

and

and together with that sweat, the venome is dispersed and expelled. But; where the Venome is so deeply settled, and as it were radicated in the solid substance of the parts, as that one or two, or three Fits of Dancing and Sweating are not sufficient to the total Eradication and Expulsion thereof; in that deplorable case, the Patient becomes freshly intoxicated, and relapseth into his dancing paroxisms, at the same periodical season, every year, without omission, till his many and profuse Annual sweats have freed him from all Reliques of the Poyson.

Art. 10. Why *Divers Tarantiacal* Persons are affected and cured with *Divers Tunes*, and the musick of divers *Instruments.*

Most true it is, that Divers Tarantiacal persons are affected with divers Musical Instruments, and divers Tunes and Ayrs; but this is to be imputed to the Diversity of Complexions and Temperaments either of the Tarantula's, which envenome them, or of the Persons themselves. For, such as are Melancholy of themselves, or intoxicated by the poyson of the duller and more sluggish sort of Tarantula's; are ever Affected and Sympathize rather with the musick of Drums, Trumpets, Sackbuts, and other loud and strong sounding instruments, than with that of Lutes, Vials, Vialins, and other soft and gentle ones. For, since Melancholy is a thick, heavy and viscid Humor, and the Spirits alwaies follow the Disposition of the Humor prædominant; to the Concitation and Dissipation thereof, a greater force of motion is required. And this, doubtless, was the Reason, why a certain Girl of *Tarentum*, being there bitten by a Tarantula, and affected with the stupendious symptome of Tarantism, could never be excited to dance by any sounds, but those of Guns, Alarms beaten upon Drums, Charges and Triumphs sounded in Trumpets, and other military musick; the heavy and viscid venome, meeting with a body of a Cold and Phlegmatick Complexion; and so requiring very strong Commotions of the Aer and Spirits, to its Estuation and Dissipation. And, on the Contrary, Cholerick and Sanguine Complexions, are, by reason of the Subtility of their Spirits, and greater Fluidity of their Humors, soonest Cured by the Harmony of Lutes, Harps, Vials, Virginals, Guitarrs, Tiorba's, and other stringed Instruments.

Art. 11. That the venome of the Tarantula doth produce the same effect in the body of a man; as it doth in that of the Tarantula it self: and *why.*

But; that which deserves our highest Admiration, is this; that *this Venome of the Tarantula doth produce the same Effect in the body of man, which it doth in that of the Tarantula it self; wherein it is generated:* as if there were some secret Cognation and Similitude betwixt the Nature of that venemous Spider, and that of Mankinde. For, as the Poyson, being infused into any part of mans body, and set a work by Musick, doth, by a continual vellication or Titillation of the Muscles and Membranes thereof, incite the intoxicated person to dance: So likewise, while it remains in its own womb and proper Conservatory; the body of the Tarantula being once set a work by Musick, doth it incite the Tarantula to dance, and caper, as is commonly observed by the Italians, and at large related by *Athan. Kircherus* (*in opere Magnetico*) and some others of unquestionable veracity, who would admit no testimony in this particular, but what they received from their own exact observations. Among the sundry Narrations of Experiments in this kind, *Kircher* entertains his Reader cheifly with this one, as the most exact and commemorable. 'A certain Italian Duchess (sayes He) to the end she 'might be fully satisfied of the truth of this prodigy of nature, of which 'she had so often heard, and as often doubted, commanded that a Tarantula

'should be brought into the Hall, or Refectory of a Colledge of Jesuits, 'all the Fathers being præsent; and there set upon a small chipp of wood, 'that floated in a dish of water. Then she gave order, that an Excellent 'Harper should stand by, and play over several of his best composed 'Tunes. The Tarantula, for a good while, seemed wholly unconcerned 'in the musick, discovering no motions of tripudiation in himself; but 'at length, when the Harper had hit upon some certain Notes, Strains, 'and Ayres, such as held some proportion to the Humor and Specifical 'Venome of the Spider, the now enchanted Insect began to detect its sym-'pathy to Musick, and natural inclination to dancing, not only by the 'frequent lifting up his feet, and nimble agitation of his whole body, but 'even most exactly observ ng time and measures, according to the Harmo-'nical Numbers exprest in the Tune: and as the Musician plaid more slow-'ly or swiftly, so did the little beast dance more slowly or nimbly; not 'moving a foot, after the Tune was ended. But, this which then appeared so rare to the Dutchess and other Spectators, they soon after heard to be very common to the Musicians of Tarentum, who being hired, with an annual pension paid out of the Publique purse, to cure the meaner sort of the people, when any is bitten by a Tarantula; that they may not miss of healing the Patient, and put themselves to the pains of playing long: they first enquire of the Patient, in what house, what field, or place he was bitten, of what colour and bigness the Tarantula was, that bit him. Being satisfied of these particulars, they forthwith go to the place described, and there looking among the several species of Tarantula s, as they are busie in weaving their Cobweb nets, for the ensnaring of Flyes; they search for such a one as the Patient hath described, and having once found the like, they instantly fall to their instruments; and play over whole sets of Lessons one after another, till they light upon such a one, as holding some proportion to the Specifical temperament and venemous Humor of that Tarantula, inciteth him to dance. And both exceeding delightful and strange it is to behold the great variety of Humors among many Tarantula's together; one while this sort, another while that exactly sympathizing with the Harmonious motions of the strings and aer. When the Musicians have thus informed themselves of the particular Genius and Humor of that species of Tarantula's, by one of which the Patient was envenomed; they return home, and set him a dancing almost at first touch of their instruments, playing over again and again those Tunes, whose Correspondency to the poyson, that lieth ambuscado'd in the centrals of his bodie, they had formerly experimented: and they seldom or never fail of the Cure, where they are certain what Notes and Tunes are most accommodate to the Genius of the Spider, that hath intoxicated the Patient.

Nor is it at all inconsistent with Reason, that the Tarantula it self should suffer the same strange Effect from the Charms of Musick, as the man doth whom its Venome hath intoxicated: for seeing that the Humor, which supplies the office of Blood in this Insect, is exceeding viscous, and impræegnate with subtle and hot spirits, and so becomes a subject very convenient to receive the Motions impressed upon it, by the most subtle parts of the Aer, whereof the Sounds are composed: it seems almost necessary, that being æstuated and set afloat, by the motions of the

aer,

aer, which are Harmonical; it ſhould cauſe the like Vibriſſations in the nervous parts of the Tarantula, as the hand of the Muſician hath cauſed in the Conſonous ſtrings of the inſtrument; the ſtrings cauſed in the Aer, and the Aer cauſed in the ſpirits of the Animal: and conſequently, that the Animal ſhould ſuffer a kind of Itch, or gentle vellication in all its nerves, and muſcles, and to eaſe it ſelf of that troubleſom Affection, move all its members, not only with great agility, but variety of motions correſpnodent to thoſe of the Harmony impreſſed upon its ſpiritual ſubſtance; eſpecially where the Harmony is proportionate to the ſpecifical (and perhaps, individual) Conſtitution of the ſame.

Art. 12. That the Venom of the Tarantula is lodged in a *viſcous Humor*; and ſuch as is capable of *Sounds*.

That the vital Humor of theſe and moſt other Spiders, is both *viſcous, and a ſubject capable of Sounds*, as we here aſſume; may be inferred from the relation of *Peter Martyr* (*in Hiſtor. ſua Indiæ Occidental*) that in the *Weſt Indies* there is a certain ſpecies of Phalangiums, or Venenate Spiders, whoſe poyſon, being expreſſed, is ſo exceedingly viſcid and tenacious, that the Natives uſe to draw and ſpin it out into long threads, and twiſt thoſe threads into Treble ſtrings for their inſtruments of Muſick: as alſo from our own ocular teſtimony, whenever we preſs a Spider to death.

Art 13. That it cauſeth an unceſſent *Itching* and *Titillation* in the Nervous and Muſculous parts of mans body, when infuſed into it, and fermenting in it.

And (what is of greateſt moment to our præſent Diſquiſition) that the *Venome of the Tarantula, by reason of the Acrimony, or Mordacity of its Spiritual and hot particles, cauſeth an unceſſent Titillation, or Itching joyned with great heat, in the nervous and muſculous parts of mans body*, when it is in æſtuation and commotion therein, may be collected from the agreeing relations of all perſons, who have known the miſery of Tarantiſme: every one complaining of an inſufferable Itch in all parts of his body, during the paroxiſme, and finding a remiſſion of the ſame immediately after profuſe ſweating. For your farther Confirmation herein, be pleaſed to hear Father *Kircher* tell you a memorable and pertinent ſtory. 'A certain Cap-
'pucine (ſaith He) of the Monaſtery belonging to that Order, in *Tarentum*,
'being bitten by a Tarantula, and by his (in that point, too ſevere) Superi-
'ors forbidden to have recourſe either to Baths, or Dancing, for the cure
'of his infection, as means that might ſeem too light and inconſiſtent with
'the gravity and rigid rules of his Profeſſion; was ſo miſerably and beyond
'all patience tormented with an itching and burning in both the interior and
'and exterior parts of his body, that reſt and quiet were things he had long
'ſince been a ſtranger to; and hoping to find ſome eaſe and allay of his
'reſtleſs pains by bathing in cold water, he, one night, privily conveyed
'himſelf out of the Covent, and leaped into an Arm of the Sea, that em-
'braced the town. Where, indeed, he met with a perfect cure of all his
'torments and grievances; being inſtantly drowned: leaving his Brethren
'to lament their own great loſs, as well as the Sadneſs of his Fate; and his
'Superiors to repent the cruelty of that Superſtition, which had denied him
'the uſe of thoſe innocent Remedies, Muſick and Dancing, which the
'happy experience of many thouſands had præſcribed.

Laſtly, as it is not every Harmonical Ayre that ſuits with the Genius of every Tarantula, but every particular ſpecies holds a ſecret Correſpondence to ſome particular ſorts of Inſtruments, Tunes, and Strains compoſed of ſuch and ſuch Notes: So likewiſe is it not the Muſick of every inſtrument, nor every modulation of ſounds that move and

excite every person infected with this kind of poyson; but every Tarantiacal Patient requires such and such particular Harmonious Tunes, Strains, and Notes as are proportionate to that Diathesis, or Disposition, which results from the Commixture and Confermentation of his owne Humors, and the Venome infused into his body. Which is the Reason, why some dance to no musick but that of Drums, Trumpets and other loud and martial instruments; and others again are easily charmed to Levolta's by the mild and gentle Consonances of Lutes and Tiorba's. And if the Patient, being of a *hot and bilious* Complexion, be intoxicated by the venome of a Tarantula of the like Cholerick temperament; upon the æstuation and confermentation of those two consimilar Humors, the Patient shall become *Feverish*, insatiately *thirsty*, *restless*, and *furiously maniacal*: but, where a *Melancholy* Tarantula hath empoysoned a man of the like dull and sluggish Constitution; in that case, He shall be infested with great and inexpugnable *Drowsiness*, *Stupidity*, *Spontaneous Lassitude*, love of *Solitude*, unseasonable and affected *Silence*, and the like Symptoms contrary to the former, and shall be relieved only by grave and solemne tunes; the Accidents supervening upon this kind of intoxication, alwayes following and betraying the capacity of the prædominant Humor, and responding to that Harmony, which hath the most of proportion to the Genius of the Poyson.

Art. 14. The cause of the *Annual Recidivation* of the Tarantism, till it be perfectly cured.

And as for the *Annual Relapses* of Patients, into their Tarantiacal Fits; the *Cause* thereof must be only this, that the Reliques of the Poyson causing a fresh Commotion and Fermentation of the most susceptible Humors of the body, and especially of the Serous and Bilious part of the blood(for, most persons thus affected; have their Paroxysms in the hottest season of the year) and imbuing them with exceeding great Acrimony and Mordacity: diffuse themselves through the Arteries and Veins into all parts of the body; and fixing more especially on the thin membranes, that invest the muscles, so oppress, prick and vellicate them, as that the infected shall know no rest nor ease, till he hath danced and sweat; to the dissipation and expulsion of all those sharp and pungent particles, that were diffused into the Habit of his body.

Art. 15. A Conjecture, what kind of *Tunes*, *Strains* and *Notes* seem most accommodate to the Cure of *Tarantiacal* Persons in the *General*.

But, what *particular Sounds*, *and Notes*, *and Strains*, *and Ayres*, are Accommodate to the Venome of this or that particular Tarantula; we leave to the determination of the long experienced Musicians of Tarentum only thus much we may say, in the General; that by how much the more frequent Diminutions of Notes into halfs and quarters (which is called Division) and the more frequent permistion of Sharps and Flats, in a Tone charged with frequent Semitones, the Tune containeth: by so much the more grateful will the same be to all Tarantulized Persons; because, from the Celerity of the motions it comes, that the Dormant Venome is more nimbly agitated, and so must sollicite them to dance the more spritely and vehemently. Hence is it, that the Musicians of *Italy*, such especially who profess the certain and speedy Cure of the Tarantisme, for the most part, enrich and adorne their strains with various Divisions of Notes; and that mostly in the *Phrygian* Tone, because it consisteth of frequent Semitones.

(8) What

(8) What we have here said, concerning the Magick of Harmonious Sounds both upon the Tarantula it self, and those unhappy men, whom its Fascinating venome hath Tarantulized; as it doth wholly take off the Incredibility of those Relations, which some Natural Magicians have set down, of the *Incantation of Serpents, by a wand of the Cornus, or Dog tree*: so doth it also give us no obscure light into the dark Cause of that Effect, which among the Ignorant and Superstitious hath ever passed for meerly præstigious and Diabolical. For, it being certain, that all Serpents are most highly offended at the smell, and influx of those invisible Emanations proceeding from the Cornus, by reason of some great Disproportion or Incompossibility, betwixt those subtile Effluvias, and the temperament of the Vital and Spiritual Substance of Serpents: insomuch that, in a moment, they become strongly intoxicated thereby: Why should it seem impossible, that He, who understands this invincible Enmity, and how to manage a wand or rod of the Cornus with cunning and dexterity; having first intoxicated a Serpent by the touch thereof, should, during that fit, make him observe and readily conforme to all the various motions of that wand: So as that the unlearned Spectators perceiving the Serpent to approach the Enchanter, as he moves the wand neerer to himself; to retreat from him, as he puts the wand from him; to turne round, as the wand is moved round; to dance, as that is waved to and fro; and lye still, as in a trance, when that is held still over him; and all this while knowing nothing, that the simple virtue of the wand is the Cause of all those mimical motions and gestures of the Serpent: they are easily deluded into a belief, that the whole scene is supernatural, and the main Energy radicated in those words, or Charms, which the Impostor, with great Ceremony and gravity of aspect, mutters forth, the better to disguise his Legerdemane, and dissemble Nature in the Colours of a Miracle.

Art. 16. The Reason of the *Incantation of Serpents*, by a rod of the *Cornus*.

And, as in this, so in all other Magical Practices, those Bombast Words, nonesense Spells, exotique Characters, and Fanatick Ceremonies, used by all Præstigiators and Enchanters, have no Virtue or Efficacy at all (that little only excepted, which may consist meerly in the sounds, and tones in which they are pronounced, in respect whereof the eare may be pleased or displeased) as to the Causation of the Effect intended; nor doe they import any thing, more than the Circumvention of the Spectators judgement, and exaltation of his Imagination, upon whom they prætend to work the miracle. Which considered, it will be an argument not only of Christianism, but of sound judgement in any man, to conclude; that excepting only some few particulars, in which God hath been pleased to permit the Devil to exercise his Præstigiatory power (and yet, whoso shall consider the infinite Goodness of God, will not easily be induced to beleive, that He hath permitted any such at all.) all those Volumes of Stories of Fascinations, Incantations, Transformations, Sympathies of men and beasts with Magical Telesms, Gamahues or Waxen Images, and the like mysterious Nothings, are meer Fables, execrable Romances. So Epidemical, we confess, hath the Contagion of such Impostures been, that among the People, when any Person waxeth macilent, and pines away, we hear of nothing but Evil Neighbours, Witchcraft, Charms, Statues of Wax, and the like venefical fopperies; and instantly some poor decrepite old woman is suspected, and

Art. 17. DIGRESSION. That the *Words, Spells, Characters*, &c. used by *Magicians*, are of no vertue or Efficacy at all, as to the Effect intended; unless in a *remote* interest, or as they exalt the *Imagination* of Him, upon whom they prætend to work the miracle.

and perhaps accuſed of malice and Diabolical ſtratagems againſt the life of that perſon: who all the while lieth languiſhing, of ſome Common Diſeaſe, and the learned Phyſician no ſooner examines the caſe, but he finds the ſick mans Conſumption to proceed from ſome inveterate malady of the bodie, as Ulcer of the Lungs, Hectique Fever, Debility of the Stomack, Liver, or other common Concocting part, or from long and deep Grief of mind. In like manner, when the Husband-man obſerves his field to become barren, his chattel to caſt their yong, or die, his corn to be blaſted, his fruits to fall immaturely, or the like ſiniſter Accidents: nothing is more uſual with him, than to charge thoſe misfortunes upon the Magical Impræcations of ſome offended Neighbour, whom the multitude ſuppoſeth to be a Cunning man, or Conjurer. And yet, were the Philoſopher conſulted about thoſe Diſaſters, he would ſoon diſcover them to be the ordinary and genuine Effects of Natural Cauſes, and refer each Contingent to its proper original. True it is likewiſe, that many of thoſe Sorcerers, whom the vulgar call *White Witches*, in reſpect of the good they prætend to do, frequently præſcribe certain Amulets, or Periapts, for the prævention or cure of ſome diſeaſes: and in this caſe, if the Amulet or Periapt, be compoſed of ſuch Natural Ingredients, as are endowed with Qualities repugnant to the Diſeaſe, or its germane Cauſes, we are not to deny their efficacy. But, as for thoſe ſuperſtitious Invocations of Angels and Spirits, Salamons Characters, Tetragrammatons, Spells, Circles, and the like vain and ridiculous Magical Rites and Ceremonies, uſed by the Sorcerer, at the time of the Compoſition or Application of thoſe Amulets or Periapts; they are of no power, or virtue at all, and ſignifie nothing but the Deluſion of the Ignorant. Again, we grant, that the Imagination and Confidence of the ſick Perſon, being by ſuch means exalted, may conduce very much to his Recovery; for, it is no ſecret, that the minds of Languiſhing men are, for the moſt part, erected, and their drooping ſpirits as it were Re-inforced, by the good opinion they have entertained of the Phyſician, and the Confidence they place in his præſcripts: but, yet are we not therefore to allow any Direct and Natural Efficacy to that ſuperſtitious præparation, and Ceremonious adminiſtration of Remedies, which are alwaies obſerved by ſuch Impoſtors, as prætend to Extraordinary skill, and ſome ſupernatural way, in the Cure of Diſeaſes, and ſeem to affect and glory in the deteſtable repute of Magicians. And what we ſay of the Cure of Diſeaſes, by Periapts, Amulets, and the like, we deſire ſhould be underſtood alſo of Magical Philtres, or Love-procuring Potions, of the Ligature of the point, on the Wedding night, to cauſe Impotency in new married men toward their Brides (a thing very frequent in *Zant* and *Gaſcony*) and the like effects: becauſe each of theſe hath other Cauſes, than thoſe remote and unconcerned Nugaments præſcribed by thoſe Cheaters; and all the influence and power they can have upon the perſons, to whom they are præſcribed, conſiſteth only in the præpoſſeſſion of their Phancy, and the ſtrength of perſuaſion to Hope, or Fear.

Art. 18. The Reaſon of the *Faſcination* of *Infants*, by *old women.*

(9) There is, beſides, a certain ſort of *Faſcination Natural*, about which no ſmall adoe is kept in the world, and moſt Nurſes, when they obſerve their Infants not to thrive, or fall into Cachexies, languiſhing conditions, Convulſions, or the like, inſtantly crie out, that ſome *envious Beldam hath overlooked them.* Concerning this ſecret therefore, in which Imagination (on the Infants part) hath no intereſt at all; we ſay. tha

that if there be any thing of truth, as to matter of Fact, the Fascinating activity of the old malicious Crone must consist only in this: that she doth evibrate or dart forth from her brain, certain malignant Spirits, or rayes, which entering the tender body of the Infant, do infect the purer spirits, and so the blood in its Arteries, and assimilating the same to their depraved and maligne nature, corrupt all the Aliment of the body, and alienate the parts from their genuine and requisite temperament. Not that those Malignant Emissions can arrive at, and infect an Infant that is absent, as is vulgarly conceived; but that the malicious old woman must be præsent, and look (with an oblique or wist look) and breath upon the Child, whose health she envies, nay, conjure up her Imagination to that height of malice, as to imbue her spirits with the evil Miasme or Inquinament of those vitious and corrupt Humors, wherewith her half-rotten Carcass is well stored; and to assist the Contention of her optique Nerves and Muscles, that so those Spirits may be ejaculated with great force. For, that an old woman though as highly malignant in her Nature and Malice, as can be supposed, should be able to infect and envenome an Infant at great distance; is not to admitted by any, but such as have ignorance enough to excuse their persuasion of the highest Impossibility imaginable. But, that she may, in some measure, contribute to the indisposition of an Infant, at whom she shoots her maligne Eye-beams, neer at hand; may receive much of credit from the Pollution of a Lookinglass by the adspect of a Menstruous woman; and from the Contagion of Blear Eyes, Coughing, Oscitation or Gaping, Pissing and the like: all which are observed to be somewhat infectious to the standers-by.

Art. 19. The Reason of the *stupefaction* of a mans hand by a *Torpedo*.

(10) You may call it *Fascination* also, if you please, when the *Torpedo doth benumb or stupifie the hand of the Fisherman*. For, as the Maleficiation of Infants is the Effect only of certain malign or ill conditioned Emanations transmitted to them from the brain of some malevolent and half venemous Ruines of a woman: so likewise must the stupefaction of the hand of the Fisherman, be the Effect of certain Stupefactive Emanations, either immediately, or by the mediation of a staff or other continued body, transmitted thereunto from the offended Fish; which Emanations, by a Faculty holding some neer Analogy to that of *Opium Hyosciamus*, and other strong *Narcoticks* or stupefactive Medicaments, do in a moment *Dull* and *Fix* the Spirits in the part, that they invade, and so make it Heavy, Senseless, and unfit for voluntary motion.

Art. 20. That ships are not *Arrested* in their course, by the Fish called a *Remora*: but by the Contrary impulse of some *Special Current* in the Sea.

(11) But, how shall we get free of that Difficulty, wherein so many high-going Wits have been Gravell'd; *the sudden arrest of a ship, under sail, by the small Fish Echineis*, thereupon general called a *Remora*? We cannot expede our selves from it, by having recourse to any Fixing Emanations transmitted from the Fish to the ship; because the Motion thereof is not voluntary, but from External Impulse; nor hath the ship any spirits, or other Active principles of motion, that can be supposed capable of Alteration by any influx whatever. Nor by alleaging any motion, contrary to that of the tide, winds, and oares, impressed upon the ship by the Remora; because, whatsoever kind of Impulse or Force can be imagined impressible upon it thereby: yet can it never be sufficient to impede and suppress the so violent motion thereof; insomnch as the Remora, neither adhæring to any rock, shelf, or other place more firme than the water, but only to the ship it

self;

ſelf, muſt want that fixation & Firmitude, that is inevitably neceſſary, whenever any thing doth ſtop, or move another thing of greater weight then it ſelf. What then? ſhall we impeach of unfaithfulneſs all thoſe Authentick Hiſtorians, who have recorded the ſuddain and prodigious Arreſts of the ſhips of *Periander* *Antigonus*, and *Caius Caligula*, in the middeſt of their Courſes, though therein advantaged by the Conſpiring impulſes of Sails and Oares? Not ſo neither; becauſe many other veſſels, as well before as ſince, have been ſtopped in the like manner: and there is in nature Another Cauſe, incomparably more potent, and ſo more likely to have arreſted them, than that ſoft, ſmall and weak Fiſh Echineis; and that is the Contrary motion of the ſea, which our Mariners (who alſo have been often troubled with the experiments of its Retropellent Force) call the *Current*; which is alwayes moſt ſtrong and cumberſome in narrow and aufractuous Chanels. Which being ſcarce known to the Sea-men of thoſe times, when Navigation and Hydrography were yet in their infancy, and few Pilots ſo expert, as to diſcriminate the ſeveral Re-enconnters, or Contrary Drifts of Waters in one and the ſame Creek or Arme of the Sea; when they found any veſſel ſuddenly retarded and impeded in its courſe, they never conceived that Remoration to ariſe from ſome Contrary Current of Waters in that place, but from ſome Impediment in the bottome or keel of the veſſel it ſelf. And as they ſearched there for it, if it hapned twice or thrice, that they found ſome ſmall Fiſh, ſuch as the *Concha Veneris*, or any other not much unlike a *Snail*, adhæring to the lower part of the Rudder, or Keel; they inſtantly, and without any examination at all, whether ſo weak a cauſe might not be inſufficient to ſo great an Effect, imputed the Remoration of their veſſel thereunto. Hiſtorians, indeed, tell us, that the Admiral Galley, which carried the Emperour *Caligula*, in his laſt voyage to *Rome*, was unexpectedly Arreſted, in the middeſt of all his numerous Fleet; and that an Echineis was found ſticking to the bottom thereof: but they forgot to tell us, whether or no there were any other Fiſhes of the ſame kind affixed to any other of the Galleys, that kept on their courſe; and we have good reaſon to conjecture, that there were, becauſe very few ſhips are brought into Havens and Docks to be carined, but have many ſmall fiſhes, reſembling Snails, adhæring to their bottoms, as ourſelves have more than once obſerved in *Holland*. Beſides, ſince, at *Caligula*'s putting forth from *Aſtura*, an Iſland Port, and ſteering his courſe for *Antium*, his Galley, as is the cuſtome of Admirals, kept up in the middle Chanell; why might it not be encountred and oppoſed by ſome ſpecial current, or violent ſtream, in that place, ſo ſtreitly pent in on both ſides by the ſituation of certain Rocks and Shelves, as that its greateſt force was in one certain part of the Chanell, and ſo not extenſible to the other Galleys of his Navy, that were rowed neerer to the ſhoars, and ſo rode upon free water? For, thus ſhips are now adayes often Arreſted by ſpecial Currents, in the *Fretum Sicilienſe*, whoſe Chanels are rocky, aufractuous, and vorticous, or obnoxious to frequent Eddies and ſtrong Whirlepools; and neer *Gaditanum* you may every day behold the Contrary Drifts of ſhips by the Contrary Currents in the ſame Arme of the Sea; ſome veſſels being carried toward the ſhoars, whether the ſea runs out, while others ride toward the Chanel, where the ſea runs in.

(12) So

(12) So unlimited is the Credulity of man, that some have gone farther yet from the bounds of Reason, and imagined a *Second* wonderful Faculty in the *Remora*, viz. the *Præsagition of violent Death, or some eminent Disaster, to the chief person in the ship, which it arresteth.* For, *Pliny* (*lib. 9. cap. 25. & lib. 23. cap. 1.*) will needs have it a Prodigy portending the murder of *Caligula*, which ensued shortly after his arrival at *Rome* from *Astura*: and that by the like arresting of the ship of *Perianders* Ambassadors sent to obtain an edict for the Castration of all Noble youths, Nature did declare her high detestation of that Course so destructive to the way of Generation, that she had instituted for the Conservation of her noblest species. But, every man knows, how easie it is to make any sinister Accident the Omen of a tragical Event, after it hath happened: and that *Plinies* Remark upon the inhuman Embassie, and succeeding Infortune of *Perianders* Messengers, would better beseem the ranging pen or tongue of an *Orator*, than the strict one of a *Philosopher*.

Art. 21. That the Echineis, or Remora is not *Ominous*.

(13) Here, we should open and survey the whole Theatre of *Venoms* or *Poisons*, on one hand; and that of *Antidotes*, or *Counterpoisons*, on the other: *those* operating to the *Destruction*, *these* to the *Muniment* and *Conservation* of *Life*; and both by such *Qualities* and wayes, as are generally both by Physiologists and Physitians, præsumed to be *Occult*; or beyond the investigation of Reason, and of which all that is known, is learned in the common School of Experience. But, worthily to examine the Nature of each particular Poison, among those many found in the lists of Animals, Vegetables, Minerals; and explicate the Propriety; by which its proper Antidote or Alexipharmacon doth encounter, oppose, conquer and expel it: must of necessity enlarge this Section into a Volume, besides the expence of more time, than what we have consigned to our whole Work. And, therefore, we hope our Reader will not conceive his expectation wholly frustrated, nor Curiosity altogether defrauded; though we now entertain Him only with the *General* Reasons, Why Poisons are Hostile and Destructive, why Counterpoisons friendly and Conservative of Life.

Art. 22. Why this place admits not of more than a *General* Inquest into the *Faculties* of *Poisons* and *Counterpoisons*.

Gwoinus (*de Venen. lib. 2. cap. 24.*) we well remember, defines *Venenum*, Poison, to be [*quod in corpus ingressum, vim infert, Naturæ illamque vincit*] *That which being admitted into the body, offers violence to Nature, and conquers it.* And, according to this Definition, by *Poisons* we understand not only such things, as bear a pernicious Enmity in particular to the temperament of the Heart, or that substance, wherein the Vital Faculty may be conceived principally and immediately to consist: but *all such as are hostile and destructive to the temperament of the Brain, or any other Noble and Principal Organ of the body, so as by altering the requisite Constitution thereof, they subvert the œconomy and ruine the frame of Nature, wherein the Disposition of the parts, to perform the Actions of Life, is radicated.*

Art. 23. *Poisons* defined.

And that, wherein this *Deleterious* or *Pernicious Faculty* doth consist, we conceive to be a certain *Substance*, which being communicated or infused into any part of the body, though in very small quantity, doth, by reason of the exceeding *Subtility* and violent *Mobility* or *Agility*

Art. 24. Wherein the *Deleterious* Faculty of Poison doth consist.

Agility of the insensible particles, of which it is composed, most easily and expeditely transfuse or disperse it self through the whole body, consociate it self to the spirits, and invading the Heart, Brain, or other Principal Organ, so alter the requisite Disposition or temperament and habit thereof, as to make it thenceforth wholly uncapable of performing the Functions or Actions of life, to which it was destined and framed; and by that means introduceth extreme Destruction.

Art. 25. *Counterpoisons* Defined.

Likewise, by *Alexipharmacal Medicaments*, or *Counterpoisons*, we understand, not such things, as have only a propitious and benign Friendship particularly for the temperament of the Brain, Heart, or other Noble Organ in the body, and are therefore accounted specifically Auxiliant and Corroborative thereunto, in the Expulsion of ought, that is noxious and offensive unto it; because, in that sense, all Cardiacal, Cephalical, and Specifically Corroborative Medicaments would be Alexiterial, and every peculiar Venome would not require its proper Antivenome, both which are contradicted by Experience: But, *such things as are endowed with Faculties è diametro and directly Contrapugnant to Poisons, meerly as Poisons*; For, divers things that are absolute Poisons of themselves, and would destroy, if taken alone by themselves, do yet become powerful Præservatives and Antidotes against other poisons, and afford suddain and certain relief to nature, when taken to oppose them. Thus *Aconite*, than which scarce any venome is more speedy and mortal in its operation upon a sound body, doth yet prove a præsent remedy to one bitten by a *Scorpion*, if drank in Wine: as *Pliny* hath observed (*lib.* 27. *cap.* 2.)

Art. 26. Wherein their *Salutiferous* Virtue doth consist.

And that, wherein this *Salutiferous Virtue of Antidotes* doth consist, we conceive likewise to be a certain *Substance*, which being received into the body, though in small quantitie, doth with expedition diffuse it self throughout the same: and encountering the venome formerly admitted, and then operating, refract its energy, prævent its further violence, extinguish its operation, and at length either totally subdue, or totally educe it. For, All Alexipharmacal Remedies do not bring relief to nature, assaulted and oppressed by Poison, by one and the same way or manner of operation; some working by way of *Repulsion*, others by way of *Abduction*, others by way of *Opposition* and downright *Conquest*, when they are taken *Inwardly*: some by *Retraction*, others by *Extinction*, where they are applied *Externally*.

Art. 27. How *Triacle* cureth the venome of *Vipers*

Thus *Triacle*, whose Basis or master ingredient is the *Flesh* of *Vipers*, doth cure a man empoisoned by the *Biting* of a *Viper*; only because, in respect of Consimilarity or Similitude of substance, it uniteth it self to the Venome of the Viper, which had before taken possession of and diffused it self throughout the body, and afterwards educeth the same together with it self, when it is expelled by sweating, procured by divers Cardiacal and Hidrotical, or Sudorifick Medicaments commixt in the same Composition: no otherwise than as Soap, whose principal Ingredient is oil, doth therefore take off oily and greasie spots from Clothes; because, uniting it self unto a Cognate or Consimilar substance, the Oil or Fat adhæring to the Cloth, and so assisting its Dilution and Concorporation with the Water, in

in which it self is dissolved; it carrieth the same away together with it self in the water, when that is expressed or wrung out by the hand of the Laundress. More plainly; As oyle is therefore commixed with Ashes, or Salt, in the composition of Soap, to the end it may not stain the Cloth anew, to which it is applyed, but being confused with the oil or Fat, wherewith the cloth was formerly stained, Abduce or carry off the same together with it self in the water, which is the Vehicle to both: so likewise is the Flesh of Vipers therefore commixt with so many Alexiterial Simples as concur to the Confection of Triacle, to the end it may by them be hindred from envenoming the body a new, but yet at the same time be so commixt with the Venome already diffused through the body, as that when those Alexiterial Medicaments are by Sweat or otherwise educed from the body, carrying along with them the Venome of the Vipers flesh; to which they are individually consociated, they may also abduce or carry away that venome of the Vipers tooth, which was formerly diffused through the body. And this, we moreover conceive, may be the General Reason not only of the Evacuation of Venomes by Sweat, where the Antidote works by Union and Abduction; but also of the *Evacuation* of superfluous Humours by *Elective Catharticks*, or Purging Medicaments, that specifically educe this, or that Humor: for, it may be as lawfully said, that *Like may be cured by Like, or Unlike by Unlike*; as that oil may be absterged by its Like, viz. the oil in Soap, and by something that is Unlike, viz. the Salt, or Water carrying the oil individually commixt with it.

Art. 28. How the body of a *Scorpion*, bruised and laid warm upon the part, which it hath lately wounded and envenomed; doth cure the same.

Thus also doth the body of a *Scorpion*, being bruised and layed warm to the part, which it hath lately wounded and envenomed, suddainly Retract, and so hinder the further Diffusion of the Poison that it had immitted into the body; only because the Nervous and Fibrous parts of the Scorpions body bruised, by a motion of Vermiculation recontracting themselves, as Chords too much extended, and so retracting the Venome that yet remains adhærent to them: do at the same time Extract that Consimilar Venome, that was infused into the wound. The same also may be conceived of the Cure of the venome of a *Spider*, by the body of the Spider contused, and applied to the part envenomed: and of the Cure of the Biting of a *Mad Dog*, by the Liver of the same Dog, in like manner Contused and imposed.

Art. 29. That some Poisons are Antidotes against others by way of direct *Contrariety*

Nor is it by way of Union and Abduction alone, that some Poysons become Antidotes against others; but also by that of direct *Contrariety*, *Collucta tion* and *Conquest*: for, there being great Diversity of Venoms, some must be Contrapugnant to others; and whenever any two, whose Natures and Proprieties are Contrary one to the other, meet together, they must instantly encounter and combate each other, and at last the Activity of the Weaker submit to that of the stronger, while Nature acting the part of a third Combatant, observes the advantage, and coming in with all her forces to the assistance of her Enemies Enemie, completes the Victory, and delivers Her self from the danger. Besides, we have the testimony of Experience, that Divers men have fortified their bodies against the assault and fury of some Poisons, by a gradual Assuefaction of them to others, as *Mithridates*, and the *Attick* old Woman, &c.

Art. 30. Why sundry particular men, and some whole-Nations have fed upon *Poisonous Animals* and *Plants*, without harm.

Hence we remember Another considerable *Secret* concerning Poisons, much disputed of in the School of Physitians; viz. *Whence comes it, that not only sundry Particular Persons, but even Whole Nations have fedd upon venemous Animals and Plants, without the least of harm, nay with this benefit, that they have thereby so familiarized Poisons to their own Nature, as that they needed no other Præservative against the danger of the strongest Poison, but that Venenate one of their own Temperament?* Whereto, we Answer, in a word, that that Tyrant, *Custome*. alone challengeth the honour of this wonder; such men having, by sensible degrees, or slow advance from lesser to greater Doses of Poisons, so changed the temperament and habit of their bodies, that the wildest Venoms degenerated into wholesome Aliments, and Poisons were no more Poisons to them, than to the Animals themselves, which Generate and contain them. Which duely considered, we have little reason to doubt the verity of *Galens* relation (*de theriaca ad Pison.*) of the Marsi, and Ægyptians, whose ordinary Diet was Serpents: or of the like in *Pliny* (*lib. 6. cap.29.*) concerning the Psyllæ, Tintyritæ, and Candei, who were all ophiophagi, or Serpent-Eaters: or of *Theophrastus* his story (*lib.9. de histor. animal. cap.* 18.) of certain Shepherds in Thrace, who made their grand Sallads of white Hellebor: or of *Avicens* (*lib.4. sen. 6. tract.* 1. *cap.* 6.) of a certain Wench, who living upon no other Viands but Toads, Serpents, and other the strongest poisons, and mostly upon that of Napellus, became of a Nature so prodigiously virulent, that she outpoisoned the Basilisk, kissed several Princes to death, and to all those unhappy Lovers, whom her rare beauty had invited to her bed, her Embraces proved as fatal, as those of *Jupiter* armed with his thunder, are feigned to have been to semele: or of *Jul. Cæs. Scaligers* (*Exercit.* 175.) concerning the Kings son of *Cambaia*, who being educated with divers sorts of poisons from his infancy, had his temperament thereby made so inhumane and transcendently Deleterious, that He destroyed Flyes only with his breath, killed several women with his first nights Courtship, and pistolled his Enemies with his Spittle; like the serpent *Ptyas*, that quickly resolves a man into his originary Dust, only by Inspuition, as *Galen* reports (*de theriaca ad Pison. cap.*8.)

Art. 31. The Armary *Unguent*, and *Sympathetick Powder*, impugned.

The Rear of this Division of Secrets concerning Animals, belongs to the ARMARIE or MAGNETICK UNGUENT, and its Cousin German, the SYMPATHETICK POWDER, or Roman Vitriol calcined; both which are in high esteem with many, especially with the Disciples of *Paracelsus*, *Crollius*, *Goclenius*, and *Helmont*, all which have laboured hard to assert their Virtue in the Cure of Wounds, at great distance, either the Unguent, or Powder being applyed only to the weapon, wherewith the wound was made, or to some piece of Wood, Linnen, or other thing, to which any of the blood, or purulent matter issuing from the wound, doth adhære. Concerning those, therefore, we say, in short; (1) That notwithstanding the stories of wounds supposed to have been cured by Hoplochrism, both with the Unguent and Vitriol, are innumerable; yet is not that a sufficient Argument to convince a circumspect and wary judgment, that either of them is impowered with such a rare and admirable Virtue, as their admirers præsume: because many of those stories may be Fabulous; and were the several Instances or Experiments of their Unsuccessfulness summed up and alledged to the contrary, they would, doubtless, by incomparable excesses overweigh those of their successfulness, and soon counter-

counter-incline the minds of men to a suspicion at least of Error, if not of Imposture in their Inventors and Patrons. (2) Though the Examples of their success were many more than those of their Failing; yet still would it be less reasonable for us to flye to such remote, obscure, imaginary Faculties, as do not only transcend the capacity of our Understanding, but openly contradict that no less manifest than general Axiome, *Nihil agere in rem distantem:* than to have recourse to a proxime, manifest, and real Agent, such as daily producing the like and greater Effects by its own single power, may justly challenge the whole honour of that Sanative Energy to it self, which the fraud of some, and incircumspection of others have unduly ascribed to the Unguent, or Sympathetick Powder: We mean, the *Vital* (if you please, you may call it, the Animal, or Vegetative) *Faculty* it self; which rightly performing the office of Nutrition, doth by the continual apposition of the Balsam of the Blood, to the extremes of the small Veins, and to the Fibres in the wound, repair the lost flesh, consolidate the Disunited parts, and at length induce a Cicatrice thereupon. For, common Experience demonstrateth, that in men of temperate Diet and euchymical bodies, very deep and large wounds are many times soon healed of themselves; i. e. meerly by the goodness of Nature it self, which being vigorous, and of our own provision furnished with convenient means, wholesom and assimilable Blood, doth every moment freshly apply it to the part that hath suffered solution of Continuity, and thereby redintegrate the same: especially when those Impurities generated by putrefaction in the wound, which might otherwise be impediments to Natures work of Assimilation and Consolidation, are removed by the Detersive and Adstrictive Faculty of the Salt in the Urine, wherewith the wound is daily to be washed, according to the præscript of our Sympathetical Chirons. Nor is this more than what Dogs commonly do, when by licking their wounds clean, and moistning them with the saltish Humidity of their tongues; they easily and speedily prove their own Chirurgeons. (3) The Basis or Foundation of Hoplochrism is meerly Imaginary and Ridiculous; for, the Assertors thereof generally dream of a certain *Anima Mundi*, or Common Soul in the World, which being diffused through all parts of the Universe, doth constantly transferr the Vulnerary Virtue of the Unguent, & Vitriol, from the Extravenated blood adhæring to the weapon or cloth, to the wound, at any distance whatever, and imbuing it therewith, strongly assist Nature in the Consolidation of the Disunion. But, insomuch as this *Anima Mundi*, according to their own wild supposition, ought to be præsent to all other wounds in the world, no less than to that, from which the blood, whereunto the Unguent, or Vitriol is applied, was derived: therefore would it cure all other wounds, as well as that particular one; since it interveneth betwixt that wound and the Unguent or Vitriol, by no more special reason, than betwixt them and all other wounds; unless it can be proved, that some other special thing is transmitted to that particular wound from the Unguent, and that by local motion through all points of the intermediate spaces successively; which they will by no arguments be induced to concede.

Art. 326 The Authors *Retraction* of his quondam Defence of the Magnetick Cure of Wounds, made in his *Prolegomena* to *Helmonts* Book of that subject and title.

This Verdict, I præsume, was little expected from *Me*, who have, not many years past, publickly declared my self to be of a *Contrary* judgment; written professly in Defence of the cure of wounds, at distance, by the Magnetick, or Sympathetick Magick of the Weapon-Salve; and Powder of Calcined Vitriol; and excogitated such *Reasons* of my own, to support and explicate

explicate the so generally conceded and admired Efficacy of Both, as seemed to afford greater satisfaction to the Curious, in that point, than the Romantique *Anima Mundi* of the Fraternity of the Rosy-Cross, the Analogical Magnetism of *Helmont*, or, indeed, than any other whatever formerly invented and alledged. And, therefore, to take off my Reader from all admiration thereat, it is necessary for me here to profess; that the frequent Experiments I have, since that time, made, of the downright Inefficacy and Unsuccessfulness as well of the Armary Unguent, as Sympathetick Powder, even in small, shallow, and in dangerous Wounds; my discovery of the lightness and invalidity of my own and other mens Reasons, adferred to justifie their imputed Virtues, and abstruse wayes of operation; and the greater Probability of their opinion, who charge the Sanation of wounds, in such cases, upon the sole benignity and Consolidative Energy of *Nature it self*: these Arguments, I say, have now fully convinced me of, and wholly *Converted* me from that my former Error. And glad I am of this fair opportunity, to let the world know of my *Recantation*: having ever thought my self strictly obliged, to præfer the interest of *Truth*, infinitely above that of *Opinion*, how plausible and splendid soever, and by whomsoever conceived and asserted; to believe, that Constancy to any unjustifiable Conception, after clear Conviction, is the most shameful Pertinacity, a sin against the very Light of Nature, and never to be pardoned in a profest Votary of Candor and Ingenuity; and to endeavour the Eradication of any Unsound and Spurious Tenent, with so much more of readiness and sedulity, by how much more the unhappy influence of my Pen, or Tongue hath, at any time, contributed to the Growth and Authority thereof.

CHAP.

CHAP. XVI.

THE PHÆNOMENA OF THE LOADSTONE EXPLICATED.

SECT. I.

WHose Wit had the best edge, and came nearest the slitting of the hair; His, who said, that the LOADSTONE is the *real Janus*, because of its Two opposite Faces, or Poles, one whereof confronteth the North, the other the South: or His, who called it the *Egg and Epitome of the Terrestrial Globe*; because as the Egg contains the Idæa of the whole and every part of its Protoplast or Generant, so doth the Loadstone comprehend the Idæa of the whole and every part of the Earth, and inherit all its Proprieties, being Generated thereby, at least therein: or His, Who named it *The Nest of Wonders*; because, as a Nest of Boxes, it includes many admirable Secrets, one within another, insomuch, that no man can well understand the mystical platform of its Nature, till he hath opened and speculated them all one after another: or His, who affirmed it to be the *Antitype of the Poets Hydra*; because, no sooner hath the Sword of Reason cut off one Head, or Capital Difficulty, but Two new ones spring up in the place of it, nor ought any man to hope the total and absolute Conquest thereof, but by Cauterizing the veins of every *Difficulty*, i. e. leaving not so much as the seeds of a Scruple, but

Art. I. The *Nature* and *Obscurity* of the Subject, hinted by certain *Metaphorical Cognomina*, agreeable thereunto, though in divers relations.

but solving all its various Phænomenaes to the full: or His, who thought it sufficient, with *Aristotle*, to call it [ἡ λίθος] *The stone*, that singularity importing its transcendent Dignity: we freely leave to the judgment of our *Reader*.

Art. 2. Why the Author insisteth not upon the (1) several *Appellations*, (2) *Inventor* of the Loadstone, (3) *Invention* of the *Pixis Nautica*.

And, as for sundry other Enquiries, that do not in any direct or oblique interest concern the Investigation of the Causes of All, or Any of those admirable Proprieties observed in the Loadstone; such as that of the various *Appellations* given it by several Philosophers of old, by several Nations, at this day, together with the proper Original, Etymology and Reason of each: Whether it was first *Discovered* by the Shepherd *Magnes*, on Mount Ida; as *Pliny* (*lib.*36. *cap.*26.) reports out of the records of *Nicander*: Whether its *Attractive Virtue* was known not only to *Hippocrates* and other Senior Philosophers of *Greece*, but also to the Primitive Hebrews, and Ægyptians; as *Gilbert* conjectureth (*de Magnet. lib.*1. *cap.* 2.): Whether the Knowledge of its *Verticity*, *or Polary Virtue* cannot be derived higher than the top of the four last Centuries, and ought to be ascribed to a French man, together with the honour of the Invention of the *Pixis Nautica*, or Navigators Compass, about the year of Christ, M.CC. as *Gassendus* would persuade, out of one *Guyotus Provineus*, an old French Poet, who not long after, writ a Panegyrick in Verse upon the Excellency and sundry uses of the same; or to *John Goia* (alias *Gira*) of *Salerna*, who lived not till almost an hundred years after the said *Guyotus* had divulged his Poem, as *Blancanus* (*in Chronolog. Mathemat. Secul.* 2.) contends: Whether the Nations inhabiting the *Sinnæ* had the use of the Mariners Compass, before the Europeans; or whether they learned it of the European ships, that first advanced beyond the Cape of Good-hope, and coasted the Mare Rubrum, and begun Commerce with them: All these things, as being not only not easie to determine, but also scarce pertinent to our præsent scope, we refer to our Readers own enquiry, in *Gilbert*, *Cabeus*, *Kircher*, and other Authors, who promise him all possible satisfaction therein.

Art. 3. The *Virtues* of the Loadstone, in General, *Two*, the *Attractive*, and *Directive*.

To come, therefore, directly to the prosecution of our main design; we observe, that the VIRTUES of the Loadstone are, in General *Two*, one *whereby it attracteth Iron to it self*, the other *whereby it directeth both it self and Iron, which it hath impregnated by contact or influence, to the Poles of the Earth*: the *First* is called *Alliciency*, the *Other* its *Verticity* or *Polarity*. Concerniug the Cause of its *Alliciency*, or the reason of the Attraction of Iron by the Loadstone, or (if you would have us speak in the sense and dialect of Dr. *Gilbert*) the *Coition* of Iron and a Loadstone; various opinions have been conceived and asserted as well by Modern as Ancient Philosophers. Among those of the *Ancients*, that which best deserves our commemoration and consideration, is the opinion of *Epicurus*: who, lest He might seem scarcely sufficiently conscious of the great difficulty of the subject, excogitated a Two-fold Theory for its Explication and Solution; the Former of which we may easily collect from the Commentary of *Lucretius* thereupon; the Latter from the Dispute of *Galen* (*lib.*1. *de Natur. Facult.*) against it. For,

Art. 4 *Epicurus* his first Theory, of the Cause and Manner of the Attraction of Iron by a Loadstone; according to the Exposition of *Lucretius*.

Lucretius, professing to explain the Reason and Manner of the Attraction of Iron by the Loadstone, according to the Principles and judgment of

Epicurus

Epicurus, founds his Diſcourſe upon theſe Four Pillars, or *Præconſiderables*; (1) *That all Concretions do continually emit ſubtile Effluvia's, or Aporrhæa's:* (2) *That the contexture of no Concretion is ſo compact, as not to have many ſmall Vacuities, or inſenſible Pores, variouſly intercepted among its ſolid and component particles:* (3) *That the Effluvia's ſtreaming from Concretions, are not equally Congruous or Accommodate to all Bodies they meet with in the ſphere of their Diffuſion:* (4) *That the ſmall Pores, or inſenſible Inanities intercepted among the particles of Concretions, are not all of one and the ſame Circumſcription, or Figure; and ſo not indifferently accommodable or proportionate to all ſorts of Effluvia's iſſuing from other bodies, but only to ſuch, as are ſymmetrical or Correſpondent to them in Figure and Magnitude.* And then *He* proceeds to erect this ſuperſtructure thereupon.

'The Attractive Virtue of the Loadſtone, being determinate only to 'Iron and Steel (which is Purified Iron) ſeems to conſiſt in this; that 'both from the Loadſtone and Iron there perpetually iſſue forth continued 'ſtreams of inſenſible particles, or bodies, which more or leſs, according 'to their number and force of diffuſion, commove and impel the am-'bient Aer: and becauſe the ſtreams which flow from the Loadſtone 'are both more numerous and more potent, than thoſe which are emit-'ted from the Iron; therefore is the ambient Aer alwayes more ſtrongly 'diſcuſſed and impelled about the Loadſtone, than about the Iron; and 'ſo there are many more Inane Spaces therein created about the Load-'ſtone, than about the Iron. That foraſmuch as, when the Iron is 'placed within the ſphere of the Aer Diſcuſſed by the Effluxions of 'the Loadſtone, there cannot but be much of Inanity intercepted (un-'derſtand inſenſible Inanity) betwixt it and the Loadſtone; thence it 'comes, that the Aporrhæaes of the Iron tend more freely or uninter-'ruptedly toward that part, which faceth the Loadſtone, and ſo are carried 'quite home unto it: and becauſe they cannot tend thither in ſuch 'ſwarms, and with ſuch freedome, but they muſt impell the Particles 'of the Iron that are yet cohærent together; therefore muſt they alſo 'move and impel the whole maſs of Iron, conſiſting of thoſe recipro-'cally Cohærent Particles, and ſo carry it quite home to the Load-'ſtone. That, when a Loadſtone Attracteth Iron, not only through 'the Aer, but alſo through divers compact and firm bodies, and par-'ticularly through Marble; we are to conceive that there are more 'and more capacious Inanities made in that part of ſuch interpoſed bo-'dies, which reſpecteth the Loadſtone, than in that part of them, which 'confronteth the Iron. That the reaſon, why other things, as Straw, 'Wood, Gold, &c. being ſituate within the ſphere of the Aer Diſ-'cuſſed by the Effluxes of the Loadſtone, do not in like manner emit 'their ſubtile particles in ſuch numerous and potent ſtreams, as carrying 'along their Cohærent Particles with them, ſhould move and im-'pel their whole maſſes to a Conjunction with it: is only this, 'that the Particles emitted from the Iron are alone Commenſurable 'to the Inane Spaces in the Loadſtone. That, becauſe Iron tendeth 'to the Loadſtone indiſcriminately, i. e. either upward or downward, 'tranſverſly or obliquely, according to the region of its Application; 'this indifferency could not be, but in reſpect of the introduced 'Vacuities, into which the particles (otherwiſe prolabent only downward)

'are carried without Diſtinction of region. And, laſtly, that the motion of the Iron towards the Loadſtone, is aſſiſted and promoted by 'the Aer, by reaſon of its continual Motion and Agitation; and firſt 'by the *Exterior Aer*, which being alwayes moſt urgent on that part, 'where it is moſt Copious, cannot but impel the Iron toward that part 'where it is leſs Copious, or more full of Inanities, i. e. toward the 'Loadſtone: and afterward by the *Interior Aer*, which being likewiſe 'alwayes commoved and agitated, cannot but cauſe the ſtronger motion 'toward that part, where the Space is rendred more Inane. And this we conceive to be the ſummary of *Lucretius* Expoſition of *Epicurus* Opinion touching the Reaſon of the Loadſtones *Iron-attractive* Faculty.

Art. 5. His other Solution of the ſame, according to the Commentary of *Galen*.

And *Galen* (*in loco citato*) impugning the Magnetick Theory of *Epicurus*, firſt makes a contracted, but plain recital thereof, in theſe words: '*A lapide quidem Herculeo ferrum, à ſuccino verò paleus attrahi, &c. quippe effluentes Atomos ex lapide illo ita figuris congruere cum illis, quæ ex ferro effluunt, ut in amplexus facile veniant; quamobrem impactas utrinque (nempe in ipſa tum lapidis, quam ferri corpora concreta) & reſilientes deinde in medium, circumplicari invicem, & ferrum ſimul pertrahi, &c.* Wherein, beſides his uſuall fidelity in the Recitation even of ſuch opinions of other men, as he thought good to endeavour to refute, we have good reaſon to believe, that *Galen* came as near as poſſible to the true and genuine ſenſe of *Epicurus*: foraſmuch as thoſe Four Præconſiderables alledged by *Lucretius* for the ſupport of his expoſition of the Cauſe and Manner of the Coition of the Loadſtone and Iron, may be with equal Congruity accommodated alſo to this latter Epicurean Solution of the ſame problem, according to this præſent interpretation and abridgement of *Galen*. For, according to the tenour thereof, both the Loadſtone and Iron are præſumed to conſiſt of particles exactly alike in configuration, and to have the like Inane Spaces, or inſenſible pores intercepted among thoſe particles: and this upon no ſlender ground, ſeeing that the Loadſtone and Iron are perfect Twinns, being both generated not onely in the ſame Matrix, but of the ſame Materials, one the ſame Mineral Vein of the Earth. And, therefore, it is the more probable, that the particles or Atoms iſſuing in continued ſtreams from the Loadſtone, and invading Iron ſituate within the Orb of their activity, ſhould eaſily and deeply inſinuate themſelves into the pores of the Iron; and there meeting with ſtreams of other Atoms ſo exactly conſimilar to themſelves, engage them to reciprocal Cohærence, and being partly repercuſſed or rebounded from thence toward their Source, abduce thoſe Atoms along with them, to which they cohære, and by the impulſe of other cohærent particles, abduce alſo the whole and entire maſs: eſpecially ſince it is part of the ſuppoſition, that the Atoms tranſmitted from the Iron to the Loadſtone, do reciprocally move, engage, and compel the particles thereof, after the ſame manner; it being almoſt neceſſary that the Atoms on both ſides, in good part rebounding or reſilient, toward their ſources, and mutually implicated, ſhould flow together into the medium, and ſo doing, that the whole bodies or maſſes of

of the iron and Loadſtone ſhould be brought to a Conjunction in the Medium, becauſe of the Cohæſion of both ſorts of the flowing Atoms, with thoſe, of which the whole maſſes are contexed. For, notwithſtanding it be vulgarly apprehended and affirmed, that the Iron doth come to the Loadſtone, rather then the Loadſtone to the Iron; that the ſtreams of Atoms emanant from the Loadſtone, are both more numerous and much more potent; and found by Experiment that pieces of Iron do not only meet Loadſtones half way, but come quite home to them, where the Loadſtones are either much greater and weightier, or ſo held faſt in a mans hand, or otherwiſe, as that they cannot exerciſe their reciprocal tendency: yet, as *Gilbert* ſpeaks (*de Magnet. lib. 2. cap. 4.*) *Mutuis viribus fit Concurſus ad unitionem*, the Coition is not from one ſingle Attraction, but from a *Double*, συνεντελέχεια, or *Conactus*. And, as for the reaſon, why other things do not apply themſelves to the Loadſtone, as well as Iron; it may be ſaid, that the ſtreams of Atoms flowing from the Loadſtone, and encountring thoſe that are emitted from other bodies, do either paſs uninterruptedly along by them, or are not, in reſpect of their Diſſimilitude in Figures, ſo implicated or Complected with them, as in their reſilition to flow together and concurr in the medium.

Art. 6. *Galens* three Grand *Objections* againſt the ſame, briefly *Anſwered.*

And then He attempts the ſubverſion thereof, by the oppoſition of ſome Arguments, and eſpecially of theſe *Three Queries.* (1) *How ſuch minute and inſenſible bodies, as thoſe of which the Magnetick Aporrhæa's are ſuppoſed to conſiſt, can be able to Attract* [βαρεῖαν ὅπως οὐσίαν] *ſo great a weight as that of a maſs of Iron?* Whereto it may be Anſwered, in behalf of *Epicurus*, that the Magnetick Effluxes are not ſuppoſed to be ſo potent, as to draw any maſs of Iron of what weight ſoever, but only ſuch a one, whoſe bulk or weight carrieth ſome proportion to the force of the Attrahent, or Loadſtone. Again, He might have conſidered, that the motions of the Groſſeſt and Heavieſt Animals are performed by their ſpirits, that are bodies as exile and imperceptible as the Magnetick Effluviaes: that Winds, which alſo conſiſt of inſenſible particles, do uſually overturn trees and vaſt ædifices, by the impetuoſity of their impulſes: and that ſubterraneous Vapours are frequently the Cauſes of Earthquakes. And, as for the reaſon, How the Magnetick Aporrhæa's can *Deduce*, *Apprehend*, and *Detain* a maſs of Iron; He might have remembred, that the Atoms of the Magnet are conceived to have certain ſmall *Hooks*, or *Clawes*, by which they may lay hold upon the *Anſulæ*, or Faſtnings in the Iron; to have a violent *Motion*, which is the Cauſe both of their Impaction againſt, and Reſilition from the Iron, and to have a perpetual *Supply* of the like Atoms continually ſtreaming from the ſame fountain, by which they are aſſiſted in their Retraction, whereupon the Attraction may enſue, and that ſo much the more forcible, by how much nearer the Iron is præſented, in regard of the more copious Efflux, or Denſity of the Magnetical rayes. (2) How comes it, *That a piece, or ring of Iron, being it ſelf Attracted by a Loadſtone, and on one part adherent unto it, ſhould at the ſame time attract and ſuſpend another ring on the contrary part; that ſecond ring likewiſe attract and ſuſpend a third,*

that third a fourth, that fourth a fifth, &c. To this we may apply that Reſponſe of *Epicurus*, which *Galen* himſelf commemorates; *An dicemus, effluentium ex lapide particularum nonnullas quidem, ubi ferro occurſaverint, reſilire; & has ipſas eſſe, per quas ferrum ſuſpendi contingat? nonnullas verò illud ſubeuntes, per inanes meatulos tranſire quam ocyſſimè, & conſequentèr impactas in aliud ferrum proximum, cum illud nequeant ſubingredi, tametſi prius penetraverint, hinc reſilientes verſus prius, complexus alios prioribus ſimiles efficere?* For, herein is nothing ſo incongruous, as *Galen* conceives; it being not improbable, that ſome of the Magnetical Atoms, falling upon a piece of Iron ſhould be impinged againſt the ſolid particles thereof, and others of them, at the ſame time, penetrate the ſmall inanities or pores betwixt thoſe ſolid particles; after the ſame manner, as we have formerly aſſerted the particles of Light to be partly Reflected from the ſolid parts, and partly Trajected through the Pores of Glaſs and other Diaphanous bodies: nor that ſome of thoſe Magnetick Rayes, which paſs through the pores of the firſt Iron, ſhould invade a ſecond Iron poſited beyond it, and be impinged likewiſe againſt the ſolid particles of that, and ſo reflected toward their original, while ſome others pervading the Inanities of the ſecond, ſhould attract a third piece of Iron, and ſo conſequently a fourth, a fifth, and ſometimes more. And, certainly, in this caſe it is of no ſmall advantage to *Epicurus*, that the Force of the Magnetick Attraction is ſo *Debilitated* by degrees, as that in the ſecond iron it becomes weaker than in the firſt, in the third than in the ſecond, in the fourth than the third, &c. until at length it be totally evirate and decayed: becauſe, upon the ſecond there cannot fall as many rayes, as did upon the firſt, nor upon the third, as upon the ſecond, &c. as we have at large explicated, in our diſcourſe of the Cauſes of the Debilitation of Light. It may be further added alſo, in defence of *Epicurus*; that the Atoms of the Loadſtone, penetrating the ſubſtance of Iron, do ſo exſtimulate the Atoms thereof, that the Iron inſtantly ſuffering an Alteration of the poſition of all its component particles, doth in a ſort compoſe it ſelf according to their mode, and put on the nature of the Loadſtone it ſelf: and therefore it can be no ſuch wonder, that one iron Magnetified ſhould operate upon another iron, as the Magnet did upon it.

Art. 7. The inſatisfaction of the *Ancients* Theory neceſſitates the Author to recur to the *Speculations* and *Obſervations* of the *Moderns*, concerning the Attraction of Iron by a Magnet; and the Reduction of them all to a few *Capital obſervables*. viz.

But, all this, we confeſs, though it conferr ſomewhat of ſtrength and plainneſs to the opinion of *Epicurus*, cannot yet be extended ſo farr, as to equal the length of our Curioſity, concerning the Reaſon of the Coition of the Loadſtone and Iron; and therefore it imports us to ſuperadd thereunto ſo much of the *Speculations* and *Obſervations* of our Modern Magnetarian Authors, *Gilbert*, *Cabeus*, *Kircher*, *Grandamicus*, *&c.* (who have with more profound ſcrutiny ſearched into, and happier induſtry diſcovered much of the myſtery) as may ſerve to the enlargement at leaſt, if not the full meaſure of our ſatisfaction. And, in order hereunto, to the end Perſpicuity and Succinctneſs may walk hand in hand together through our whole enſuing Diſcourſe; we are to compoſe it of ſundry OBSERVABLES: ſuch as may not only conduct our Diſquiſitions through all the dark and ſerpentine wayes of Magnetiſm, and acquaint us with the ſeveral Laws of Magnetick Energy; but alſo, like the links of a Chain, ſuſtain each other, by a continued ſeries of mutual Dependency and Connexion.

The

The FIRST OBSERVABLE is; *that as well the Loadſtone, as its beloved Miſtreſs, Iron, ſeems to be endowed with a Faculty, that holds ſome Analogy to the ſenſe of Animals*; and that principally in reſpect of *Attraction.* For (1) as an Animal, having its ſenſory invaded and affected by the ſpecies of a grateful object, doth inſtantly deſire, and is accordingly carried, by the inſtruments of Voluntary motion, to the ſame: ſo likewiſe ſo ſoon as a leſſer or weaker Loadſtone, or piece of Iron, is invaded and percelled with the ſpecies of a greater or more potent one; it is not only invited, but rapt on toward the ſame, by a kind of nimble Appetite, or impetuous tendency.

Art. 8. A Parallelism betwixt the *Magnetique Faculty* of the Loadſtone & Iron; and that of *Senſe* in Animals.

(2) As ſenſible objects do not diffuſe their ſpecies of Colour, Odour, Sound, &c. to an Animal at any diſtance whatever, but have the ſpheres of their Diffuſion or tranſmiſſion limitted: ſo neither doth the Loadſtone, nor Iron tranſmit their Species or Emanations each to other, at any diſtance whatever, but only through a determinate interval of ſpace, beyond which they remain wholly inſenſible each of others virtue.

(3) As a ſenſible object, that is convenient and grateful, doth by its ſpecies immitted into the ſenſory of an Animal, convert, diſpoſe, and attract the Soul of the Animal; and its ſoul being thus converted diſpoſed and attracted toward that object, doth by its Virtue or Power, carry the body, though groſs and ponderous, along to the ſame: exactly ſo doth the Loadſtone ſeem, by its ſpecies transfuſed, to convert, diſpoſe and attract towards it the (as it were) ſoul, or ſpiritual ſubſtance of Iron; which doth inſtantly by its power or vertue, move and carry the whole maſs, or groſſer parts of it along to an union with the ſame. Certainly, it would not eaſily be believed, that a thing ſo exile and tenuious, as is the Sentient Soul of an Animal (which is only *Flos ſubſtantiæ*, the purer and ſubtler part of its matter) ſhould be ſufficiently potent to move and from place to place transfer ſo ponderous and unweildy a maſs, as that of the Body; unleſs our ſenſe did demonſtrate it unto us, and therefore, why ſhould we not believe, that in Iron there is ſomewhat, which though it be not perfectly a Soul, is yet in ſome reſpects Analogous to a Soul; that doth though moſt exile and tenuious in ſubſtance, move, and transferr the reſt of the maſs of Iron, though ponderous, groſs and of it ſelf very unfit for motion? All the Difficulty, therefore, which remains, being only about the Manner, How the Sentient Soul of an Animal is affected by and attracted toward a Grateful Object, let us conceive, that the ſenſible ſpecies, being it ſelf Corporeal, and a certain Contexture of ſmall particles effluxed from the object, ſuch as do gently and pleaſantly commove and affect the Organ of Senſe, being once immitted into the Senſory, doth inſtantly move the part of the Soul, (which is alſo Corporeal, and a certain Contexture of ſmall particles) inhærent or reſident in that Organ, and evolving the particles of the Soul converted (perchance) another way, and turning them about toward that part, from whence themſelves are derived, i. e. toward the object, it doth impreſs a kind of impulſe upon them, and ſo determine and attract the ſoul, and conſequently the whole Animal, toward the object. For, admitting this Conception, we may complete the Paralleliſm intended, thus; as the particles of a ſenſible ſpecies, tranſmitted from a grateful object, and ſubingreſſing through the organ into the contexture of the Soul, or Sentient part thereof, do ſo ſollicite it, as that it becomes

converted

converted toward, and is carried unto that particular object, not without a certain impulſe of appetite: ſo do the particles of the Magnetical ſpecies, ſubingreſſing into the Soul of the Iron, ſo evolve its inſenſible particles, and turn them toward the Loadſtone, as being thus ſollicited, it conceives a certain appetite or impetus toward the ſame, and which is more, forthwith reſalutes it, by diffuſing the like ſpecies toward it. For, as if the Iron were before aſleep and unactive, it is awakened and excited by this exſtimulation of the Magnetical Species; and being as it were admoniſhed, what is the propriety of its nature, it ſets it ſelf nimbly to work, and owns the Cognation. But, by what other way ſoever it ſhall be explicated, How an Animal is affected by, and rapt toward a ſenſible object: by the ſame way may it ſtill be conceived, how Iron is affected by, and rapt toward a Loadſtone. For, albeit as to divers other things, there be no Analogy betwixt the Nature and Conditions of an Animal, and thoſe of Iron: yet cannot that Diſparity deſtroy the Analogy betwixt them in point of *Alliciency* or *Attraction*, here ſuppoſed. Which well conſidered, *Scaliger* had no reaſon to charge *Thales Mileſius* with ridiculous Madneſs, for conceding the Loadſtone and Iron to have *Souls*: as Dr. *Gilbert* (*lib. 2. de Magnet. cap. 4.*) hath obſerved before us.

Art. 9. That the Loadſtone & Iron interchangeably operate each upon other, by the mediation of certain *Corporeal Species*, tranſmitted in *Rayes*: and the Analogy of the *Magnetick*, and *Luminous* Rayes.

The SECOND; that foraſmuch as betwixt the Loadſtone and its Paramour, Iron, there is obſerved not only an Attraction, or mutual Acceſſion, or Coition, but alſo a firm *Cohæſion* of each to other, like two Friends cloſely entwined in each others arms; and that this Cohæſion ſuppoſeth reciprocal Revinction, which cannot conſiſt without ſome certain corporeal Inſtruments, that hold ſome reſemblance to Lines and Hooks: hence is it warrantable for us to conceive, *that the ſpecies diffuſed from the Loadſtone to the Iron, and from the Iron to the Loadſtone, are tranſmitted by way of Radiation, and that every Ray is Tenſe and Direct in its progreſs through the intermediate ſpace, like a ſmall thread or wire extended, and this becauſe it conſiſteth of Myriads of ſmall particles, or Atoms flowing in a continued ſtream, ſo that the præcedent particles are ſtill urged and protruded forward, in a direct line, by the conſequent*, after the ſame manner as the rayes of *Light* flowing from a Lucid body, the Cauſe of whoſe Direction muſt be their Continued Fluor, as we have formerly Demonſtrated, at large. We may further conceive, that as the rayes of Light do paſs through a Perſpicuous body; ſo do the Magnetical rayes paſs thorow the body of Iron. That as among all the Lucid rayes incident upon a Perſpicuous body, whoſe ſide obverted to the Luminary is of a Devex figure, only one ray, *viz.* that which falls upon the middle point or centre, is directly trajected; and all the reſt are inclined or refracted toward that Direct one, in their progreſs through the aer beyond the Diaphanous body: ſo is only one of the Magnetick rayes, incident upon Iron, directly trajected through the ſame, and all the others are refracted or deflected toward that one direct. Only here is the Diſparity, that from the Diaphanous body to the Luminary no rayes are interchangeably tranſmitted: but from the Iron to the Loadſtone there are; and of theſe alſo, in their permeation thorow the Loadſtone, only one is direct, and all the reſt deflected toward that one. That foraſmuch as theſe Magnetick rayes, being hence and thence refracted, and accordingly paſſing thorow the pores of the body of the Iron, on one ſide, and

and thoſe of the Loadſtone, on the other; do varioúſly interſect each other at certain Angles, and in reſpect of thoſe angles, become like ſo many Arms embowed, or Chords inflected; and ſo perſtringe the ſolid particles interjacent among the pores: thence doth it come to paſs, that the whole maſſes or bodies being thus, on this ſide and that interchangeably perſtringed, there enſues the mutual Adduction of the one to the other, or of the leſs or weaker to the greater or ſtronger; and conſequently the Cohæſion of the one to the other, the Devinction being, as the Adduction, reciprocal. We need not advertiſe, that the Magnetick rayes are ſo much ſtronger and tenſer than the Luminous; by how much they are more Subtile and Agile: being ſuch as that in a moment they paſs thorow a very great maſs of Marble, which the rayes of Light cannot doe. Nor that the Magnetique rayes do not attract Marble, though they do attract Iron poſited beyond it; nor ſtrawes, or other lighter things interpoſed: becauſe, except the Loadſtone and Iron, no other bodies whatever do reciprocally emit and effect each other with their rayes; nor have they that Diſpoſition of their Pores or paſſages, which is neceſſary to the determinate Refraction of the Magnetique rayes, and to the conſtriction of their ſolid particles thereby.

Art. 10. That every Loadſtone, in reſpect of the Circumradiation of its Magnetical Aporrhæa's ought to be allowed the ſuppoſition of *a Centre, Axis,* and *Diametre of an Æquator:* and the Advantages thence accrewing.

The THIRD; the Magnetique Species being diffuſed by Deradiation Excentrical, and the Attraction of the Loadſtone (of a Spherical figure) being therefore *Circumradious*, or from all points of the circumference of its ſphere of Energy: it will be requiſite that we allow it to have (1) a *Centre*, as that which is on all ſides Corroborated by all the circumſtant parts; (2) an *Axis*, as that to which the virtues of all the circumjacent Fibres are contributed; (3) the *Diametre of an Æquator*, which lying in the middle of all its Fibres, may alſo contain the ſtrongeſt virtue of them all. For, having conceded this Geometrical Diſtinction of parts to a *Terrella*, or Spherical Magnet; we ſhall reap this advantage thereby, that we ſhall eaſily comprehend and deſcribe the ſeveral reaſons of Laws and Experiments Magnetical. To particularize; inſomuch as the Magnetique Rayes are diffuſed from the Centre of the Loadſtone to all points of it ſuperfice, and beyond it to the bounds of their Orb of Activity; that ray, which paſſeth through either of its Poles, doth attract only by the force of the Axis; and that, which paſſeth through the Æquator, draws only by the force of the Diametre of the Æquator; and the other rayes, which like Meridians, paſs through the other parts, draw by a Compound or Complicated force, inſomuch as they are alwayes intermediate betwixt one ray, which proceeds directly from the Axis, and is parallel to the Æquator, and another which comes directly from the Diametre of the Æquator, and is parallel to the Axis. And, becauſe the Æquator is æquidiſtant from either Pole; thence is it, that an Iron Obelus, or Needle, being præſented thereunto, ſhall be drawn parallel to the Axis, and in a direct line to the Diametre of the Æquator: becauſe all the rayes expiring from the Axis, as they are the longeſt and ſtrongeſt of all others, ſo are they alſo on each hand Equal, and equally attractive of the Extremes of the Needle; ſo that when it cannot incline to one Pole more than to the other, as being æquilibrated by two equal rivals, it muſt conſiſt in the middle betwixt them both. Again, if the Needle be præſented to any part of the Terrella, beyond the Æquator, toward either Pole, in this caſe, becauſe the ray iſſuing from the Diametre of the Æquator doth then diſplay its virtue to the height, and that ray which is derived

from

from the Axis, is not of ſo much power as another longer one paſſing through, or near to the Æquator: therefore ſhall the extreme of the Needle, toward the neareſt Pole, feeling that ſtronger virtue, be ſomewhat inclined; as if affecting to be conformed to that ray, which is direct to the Diametre of the Æquator; and it ſhall be alwayes inclined ſo much the more, by how much longer that ray is, and the other, profluent from the Axis, the ſhorter. Laſtly, becauſe in approaching very near to the Pole, the one ray becomes very long, the other very ſhort (comparatively); and ſo the Needle muſt be now almoſt right to the Æquator: thence comes it, that at the very Pole, that Extreme of the Needle, which regards it, ſhall cohære to the Pole, and ſo the Needle ſhall be diſpoſed in the ſame line with the Axis itſelf.

Art. 11. The Reaſon of that admirable *Biform*, or *Janus-like* Faculty of Magneticks: and why the Poles of a Loadſtone are incapable, but thoſe of a Needle eaſily capable of *Tranſplantation* from one Extreme to the contrary.

The FOURTH; the Loadſtone being of ſuch ſingular Contexture, and ſo admirably comparated by Nature, as that while it remains whole, the one half of its particles have a certain Polary reſpect, or manner of Converſion to one part, and the other half to the oppoſite part; and when it is cut in two at the Æquator, each ſegment, which formerly had all its particles converted one and the ſame way, doth in a moment alter their reſpect, and convert the one half of them to one part, and the other to the Contrary part: therefore doth a Needle (invigorated) though all its particles were before indiſcriminately and confuſedly poſited, likewiſe in a moment obtain a Converſion of one half of its particles to one part, and of the other half to the contrary part; and this either from its long ſituation above the earth, or affriction to a Loadſtone, or to another Needle ſtrongly Magnetified. And this is that prodigious Propriety of Magnetical Bodies, which *Cabeus* calls *Facultatem Duarum facierum*, a Faculty of Two Faces; and *Kircher* [δίμορφον] *Biformem Facultatem:* though they differ beyond reconciliation in their reaſons, or Explications of it. But, though this Janus Quality be in common as well to Iron, as to the Loadſtone it ſelf; to the former, onely by infuſion, to the latter by eſſence: yet are we to allow this Difference, that the Poles of the Loadſtone are never to be changed from one extreme to the other; but thoſe of a Needle are eaſily capable of tranſplantation, ſo that the Cuſpis, which now is ſtrongly affected to the North, may in a minute be alienated and inſpired with a reſpect to the South, onely by a præpoſterous Affriction of it to the Loadſtone. And hence comes it, that as the North pole of one Loadſtone doth not attract or unite with the North pole of another Loadſtone; ſo doth not the North Cuſpis of a Needle conform it ſelf to the North pole of a Loadſtone; provided it be only præſented, not applyed, or affricted upon it. For, from the laſt Touch or Affriction of the Loadſtone, the Cuſpis of a Needle acquireth a Verticity è diametro oppoſite to its former: in caſe it be rubbed upon a contrary pole, or upon the ſame pole with a contrary wipe or Ductus. Hence alſo is it, that if you fill a Quill with the Filings or Powder of a Loadſtone, and offer it to either of the Poles of a whole Loadſtone; it ſhall remain altogether inſenſible of its influence, and acquire no Verticity at all: becauſe all the Granules of the Powder, intruded into the quill, have their poles confuſed, ſome reſpecting this, others that, others a quite

quite contrary region. But, if you exchange the Filings of Loadſtone for the Filings of Steel, and offer either of the extrems of the quill to either Pole of a Loadſtone; it ſhall inſtantly own the Magnetique influx, and be imbued with the Polary Virtue, or Directive Faculty thereof: and this, becauſe all the Granules of the Steel powder, wanting determinate poles of their own, are indifferently diſpoſed to admit and retain the virtue of either Pole of the Loadſtone, in any part.

Art. 12. An *Objection*, of the *Averſion* or *Repulſion* of the North Pole of one Loadſtone, or Needle, by the North Pole of Another: *prævented.*

If this be true, you'l ask us, *How it comes about, that the Northern Pole of one Loadſtone doth not only not Attract, but nimbly Repel or Avert the Northern Pole of another Loadſtone, if they be brought within the orb of their power?*

And we *Anſwer*; that the Averſion is not really from the Repulſion of one North Pole by the other, but from the *Attraction* of the South Pole, which is felt and owned at that diſtance: but, becauſe the South Pole cannot be detorted toward the North, but the North Pole of the other Loadſtone muſt receed and veer from it; therefore doth that converſion ſeem, indeed, to be a kind of Fugation, which really is only an Attraction. The ſame is to be underſtood of the Auſtrine Pole of one Loadſtone, in reſpect of the Auſtrine Pole of another; and alſo of either Cuſpis of a Needle excited as well in reſpect of another Needle invigorated, as of a Loadſtone. The ſame alſo of a Loadſtone diſſected according to its Axis, when the Diviſions or Segments being never ſo little diſſociated, doe not attract each other reſpectively to their former ſituation; but the Auſtral part of the one ſegment is wheeled about to the Boreal part of the other: and ſo of the other Poles: the contrary whereunto alwayes happens, when a Loadſtone is diſſected according to the Æquinoctial.

Art. 13. Three principal *Magnetique Axioms*, deduced from the ſame Fountain

And from this one Fountain flow theſe Three Magnetique *Axioms.* (1) *Contraria Contrarijs ſunt amica; ſimilia ſimilibus Inimica*: i. e. Magnetical Poles of the ſame Aſpect and Apellation, are alwayes Enemies; and decline both commerce and conjunction each with other; and Poles of a Contrary reſpect and denomination, are alwayes Friends, and affect and embrace each other. For, to all Magneticks this is ſingular; that thoſe parts, which are friends each to other, ever regard oppoſite regions, and convert to contrary points; but thoſe, which are Enemies, regard the ſame region, and convert to the ſame point: becauſe Friendly parts may conſtitute the ſame Axis; but Adverſe cannot.

(2) *Quæ eadem ſunt uni tertio, non ſunt eadem inter ſeſe*; i. e. Two Poles of the ſame reſpect and name, are both Friends to a Third pole of the Contrary reſpect and name: but yet they are Enemies and irreconcileable among themſelves. And hence comes it, that a third Pole, being offered to either of two friendly Poles, cannot be a common friend, but a neceſſary Enemie to either. For, thoſe Poles, which are Friends, are of a contrary reſpect, one Septentrional, the other Meridional: to which a Third cannot approach, unleſs it be a Meridional, that ſhall be an Enemy to the Meridional, or a

Septentrional; that ſhall be an Enemy to a Septentrional: becauſe, Poles of the ſame Aſpect, cannot compoſe the ſame Axis, but thoſe of a Contrary doe. And this ſtarts up another ſingularity of Magnetiques; that there can be no more than Two Twinds: inſomuch as more than Two cannot compoſe the ſame Axis, in the ſame part.

(3) *Virtus ex eadem fonte petita, inimica & noxia; ex Contrarijs fontibus, amica & jucunda.* For, if you imbue the Heads of two Needles with the virtue of the ſame Pole, their Heads ſhall reciprocally turn away each from other, and mutually deſtroy each others verticity: but, if you imbue them with the virtue of Contrary poles, they ſhall unite and mutually conſerve each others verticity. Likewiſe, if a long Needle be applyed, in the middle, to either pole of a Loadſtone, and then be cut off in the place of the late Contact; the New Extremes (formerly united in the middle) ſhall inſtantly diſplay Contrary Virtues, and reciprocally avoid each other.

Art. 14. A DIGRESSION to the Iron Tomb of *Mahomet.*

And here, our Oath of Allegiance to Truth, whereby we are obliged to ſerve Her upon all occaſions, will excuſe our Digreſſion, if we ſtep a little aſide to the ſo famous Sepulchre of that greateſt of Impoſtors, *Mahomet*, and obſerve how egregiouſly falſe that common report is, concerning the ſuſpenſion of his Iron Tomb in the Aer, by the equal Virtues of two Loadſtones, the one fixt above in the arched roof, the other beneath in the floor of his Temple at *Medina Talnabi* in *Arabia.* If we conſult the Relations of Travellers concerning it, we ſhall not only not meet with any, who affirms it upon any other grounds, but the Tongue of Popular Fame, and tradition of the multitude: but alſo with ſome, that expreſly Contradict it; for, as *Voſſius* tells us, both *Gabriel Sionita*, and *Johannes Heſronita*, two learned *Maronites*, who journied to *Medina* on purpoſe to ſatisfie themſelves and others in that point, poſitively deliver, that the Tomb of Mahomet is made of White Marble, and ſtands upon the ground in the Eaſt end of that Moſque.

Les Voyages Fameux Du Sieur Vincent Le Blanc Marſeillois, p. 21. l. 1. c. 4

Quant à la ville de Medine, quelques-uns ont donné à entendre que le Sepulchre de Mahomet eſtoit là, ou à la Meque, tout de fer & ſuſpendu en l' air par le moyen de quelques pierres d' aymant: Mais c' eſt une choſe tres fauſſe, eſtant bien certain, comme ie l' ay appris ſur le lieu meſme, que ce faux Prophete mourut & fut enterre à Medine, où l' on voit encore ſon ſepulchre fort frequente de pelerins Mahometans de tous les quartiers du monde, comme eſt le Sepulchre de Jeruſalem de tous les Chreſtiens. Ce Sepulchre eſt de marbre blanc; avec les tombeaux de Ebubeker, Ali, Omar, & Otman Califs, ſucceſſeurs de Mahomet, chachun ayant au pres de ſoy les livres de ſa vie & de ſa Secte, qui ſont fort divers; &c.

And

And, if we conſult our own Reaſon, conſidering the ſetled and unalterable Laws of Magnetical Attraction; we ſhall ſoon be confirmed not onely of the monſtrous Falſity, but abſolute Impoſſibility of the Effect. For, ſhould we grant it to be in the power of humane induſtry, to place an Iron ſo præciſely in the neutral point of the Medium betwixt two Loadſtones, equally attracting it, the one upward, the other downward; as that the Gravity of the Iron, and downward Attraction of the Inferiour Loadſtone might not exceed, nor be exceeded by the upward Attraction of the Superiour Loadſtone, and ſo the Iron ſhould remain, without any viſible ſupport, Æquilibrated betwixt them, in the Aer: yet could not that poſition of the Iron be of any Duration; becauſe, upon the leaſt mutation of the temper of the Iron, or motion of it by the waving of the Aer from high winds, and divers other cauſes, the Æquilibration muſt ceaſe, and the Iron immediately determine it ſelf to the Victor, or ſtrongeſt Attractor. But, ſince what is here ſuppoſed, is wholly repugnant to the Experience of all, who have or ſhall attempt ſo to æquilibrate an Iron in the Aer betwixt two Loadſtones, as that it ſhall not feel the Attractive Virtue of one more ſtrong than that of the other: we need not long ſtudy what to think of the ſuſpenſion of Mahomets Iron Cheſt.

Nor is it leſs impoſſible, that an Iron ſhould be held up, at diſtance, in the Aer, by the Virtue of a Loadſtone placed above it: inſomuch as that force, which at firſt is ſufficient to overcome the reſiſtence of the Irons Gravity, and elevate it from the ground, muſt, as the Iron approacheth nearer, be ſtill more potent to attract it; and ſo that cannot oppoſe the Attractive Energy of the Loadſtone, in the middle of it ſphere, which was forced to ſubmit and conform unto it, in the Extremes. This we may ſoon experiment, with a Needle by a thread chained to a table, and elevated perpendicularly in the aer, by the pole of a Loadſtone: for, the Needle will nimbly ſpring up to meet the Loadſtone, ſo farr as the thread will give it ſcope; and if the thread be cut off, it inſtantly quits the medium, and unites it ſelf to its Attractor, from whoſe embraces it was before violently detained. Hereupon as we may aſſure our ſelves, that *Dinocrates*, that famous Architect, who, as *Pliny* relates (*lib.* 34. *cap.* 14.) began to Arch the Temple of *Arſinoe* in Alexandria, with Loadſtones, that ſo Her Iron Statue might remain Pendulous in the aer, to excite wonder and Veneration in the Spectators; but was interrupted in the middle of his Work both by his own death, and that of *Ptolomy*, Arſinoes Brother, who expired not long before him; died moſt opportunely in reſpect of his Reputation, becauſe He muſt have failed of the chief Deſign, though he had lived to finiſh his ſtructure: ſo alſo can it be no longer doubted, that *Ruffinus* his ſtory, of the Iron Chariot in the Temple of *Serapis*, and *Beda's* of the Iron Horſe of *Bellerophon*, ſuſtained by Loadſtones ſo cunningly poſited, as that their Virtues concurr and become adjuſted in one determinate point; are meer Fables, and fit to be told by none but doating old women in the chimney corner.

Art. 15. That the *Magnetique Vigour*, or *Perfection* both of Loadſtones and Iron, doth conſiſt in either their *Native Purity* and Uniformity of Subſtance, or their *Artificial Politeneſs.*

The FIFTH; *As one Loadſtone is ſtronger in its Attractive Virtue than another, though of the ſame, nay, perhaps, much greater bulk and weight: ſo is ſome Iron more diſpoſed than other, both to admit and conform to the Attraction of a Loadſtone, and, after invigoration, to attract and impregnate other Iron.* As for the *Vigour* and *Perfection* of a *Loadſtone*; it conſiſteth both in its Native Purity, and Artificial Politeneſs. (1) In its *Native Purity*; for, if no Droſs or Heterogeneous ſubſtance be admixt to the Magnetick Vein in the earth, from which a Magnet is extracted; then is that Loadſtone ſuperlatively potent and energetical in Attraction: and among Loadſtones of this ſincere and homogeneous Conſtitution, there are found no degrees of Compariſon, but what the Difference of their ſeveral Bulks doth neceſſarily create. But, in caſe any Heterogeneous matter be commixt with the Magnetick ſeeds or particles of a Loadſtone, at its Concretion; as it for the moſt part falls out: then muſt the Attractive Energy of that ſtone be weaker, according to the proportion of that ſpurious matter admixed thereunto. This may be confirmed from hence; that ſome very ſmall Loadſtones are more potent than very Great ones; of which ſort ſhall we account that of which *Merſennus* (*de Magnete*) affirms, that weighing but 7 Gr. in all, it would nimbly attract and elevate a maſs of Iron 17 times higher than it ſelf: and from hence, that ſome ſtones that were dull and languid before, after the ſecretion of their Droſſy and Impure parts, become very active and potent. Thus, when any Heterogeneous ſubſtance hath been, like a Cortex or ſhell circumobduced about a Loadſtone, in its concretion; if the ſame be pared or filed away, and the remaining Kernel be poliſhed; its Virtue ſhall be augmented to a very great proportion. (2) *In its Artificial Terſneſs or Politeneſs*; for, by how much ſmoother a Loadſtone is, in it ſuperfice, with ſo many the more rayes of Virtue, both Attrahent and Amplectent or Connectent, doth it touch Iron oblated unto it; and *è contra.* Likewiſe, as for the more or leſs *prædiſpoſition of Iron*, both to receive the Attractive influence of a Loadſtone, and, after excitement to attract other iron; this alſo conſiſteth either in its more or leſs of *Native Purity*, or of *Acquired Politeneſs*: becauſe, how much the nearer it comes to the pure nature of Steel, by ſo many the more parts hath it both Unitive unto the Loadſtone, and ſuſceptive of its rayes; and by how much more ſmooth and equal it ſuperfice is made, by ſo many more are the parts, by which it doth touch and adhære unto the Loadſtone; and conſequently imbibe ſo much the more of its Virtue, and *è contra.*

And this introduceth

Art. 16. That the *Arming* of a Magnet with poliſhed Steel, doth highly *Corroborate*; but as much diminiſh the ſphere of its *Attractive* Virtue.

The SIXTH OBSERVABLE; *That a Loadſtone, being Armed or Capp't with ſteel, is thereby ſo much Corroborated, that it will take up a farr greater weight of Iron or Steel, than while it remained naked or unarmed.* For, *Merſennus* had a Loadſtone, which, (as himſelf avoucheth) being naked, could elevate no more than half an ounce of Iron; but when he had armed it with pure and poliſht ſteel, it would eaſily ſuſpend 320 times a greater weight, i. e. ten pounds of Iron: a proportion not credible, but upon the certificate of Experiment. Now, the *Cauſe* of this admirable Corroboration of the Loadſtones Attractive Virtue, by a plate of poliſht Steel, can be no other

other than this; that the Loadſtone being of ſuch a rough contexture; as that in reſpect of the particles of ſome heterogeneous matter concorporated unto it, it is uncapable of that exquiſite ſmoothneſs in the ſurface, which may be obtained by ſteel; therefore can it not touch Iron ſo exquiſitely, or in ſo many points, as Steel may: and conſequently not invade it with ſo many Direct and united rayes. But, Steel being of a more ſimple ſubſtance, and cloſe contexture; may in all its ſubſtance be imbued with the Magnetique Virtue: and being poliſht, touch an Iron, to which it is admoved, with more parts, and invade it with more denſe and united rayes. For, thoſe indirect rayes, which otherwiſe the Loadſtone would diffuſe ſcatteringly through the Medium, in reſpect of the various inequalities of it ſuperfice, and multitude of ſmall pores intercepted among its particles; the Steel doth recollect, unite and tranſmit to the Iron admoved, and thereby more ſtrongly embrace and detain it. We ſay, *To Iron Admoved*; For, though the *Retentive* Virtue of a Loadſtone Armed with Steel, be by many degrees ſtronger; yet is its *Attractive* Virtue by ſome degrees weaker than that of an unarmed Loadſtone: i. e. it doth not diffuſe its Attractive virtue half ſo farr, and a ſheet of the fineſt Venice paper interpoſed betwixt an Armed ſtone and Iron, doth impede its Attraction; a manifeſt argument, that the Fortification is determined only to contact. This we confeſs *Merſennus* flatly denies, and upon his own obſervation: but till our Reader ſhall meet with ſuch a ſtone, as *Merſennus* uſed, we adviſe him not to deſert the common Experience of the impediment of the Attraction of Iron by an Armed Loadſtone, by paper interpoſed, ſince *Grandamicus*, whoſe chief buſineſs was the exact obſervation of all Magnetique Apparences, expreſly ſaith; *vix fit adhæſio ferri ad lapidem armatum, ſi vel Charta, vel aliud tenuiſſimum Corpus interponatur.* It hath, moreover, obſerved, that if a Magnet be perforated along its Axis, and a rod of poliſht Steel, exactly accommodated to the perforation, be thruſt thorow it; its orb of Attraction ſhall be much enlarged, and its Energy fortified to an incredible rate. *Conſule Jacob. Grandamicum, in Nova Demonſtrat. Immobilitatis Terræ, ex Magneticis, cap.* 5. *Sect.* 1. *pag.* 99.

Art. 17. Why a *ſmaller* or *weaker* Loadſtone, doth ſnatch away a Needle from a *Greater*, or more Potent one; while the ſmall or weak one is held within the ſphere of the great or ſtronger ones *Activity*: and not otherwiſe

Having layed down theſe *ſixe Obſervables*, which are of ſuch Capital concernment, as that there is no Effect or Phænomenon of Attraction Magnetical, that may not conveniently be referred to one, or more of them; and conſigned a probable Reaſon to each: the onely memorable Difficulty that remains, concerning the Attractive Virtue of Magnetiques, is, *Why a ſmall or weak Loadſtone doth ſnatch away an Iron from a Great or more potent one?* But, as the incomparable *Kircher* hath ſubtely obſerved, a ſmall or weak Loadſtone doth remove a Needle from a Great and Potent one, while it ſelf remains within the ſphere of the Great or ſtrong ones activity: becauſe the virtue of the ſmall or weak ſtone, is Corroborated by the Acceſſion of that of the Great or ſtrong. Which is demonſtrable from hence, that if the Needle be ſo long, that its extremes reach beyond the orb of the Great Loadſtones activity; then cannot a leſs or leſs potent one remove it away and elevate it: and in caſe one of the extremes be ſomewhat too near to either Pole of the

the Great Loadſtone, then is the Leſs ſtone much leſs able to ſubſtract the Needle than in the former caſe; becauſe ſo, the Virtue of the Great Loadſtone is augmented by the Addition of that of the Leſs.

Art. 18. COROLLARY. Of the Abduction of Iron from the Earth by a Loadſtone.

And hence, by way of COROLLARY, we obſerve; that the Abduction of a piece of Iron from the Earth by a Loadſtone, is ſo farr from being a good Argument againſt the Earths being Magnetique, or one vaſt Loadſtone; that it rather makes for it: becauſe the Loadſtone being applied to the Iron, and operating within the ſphere of the Earths Virtue, is ſo Corroborated thereby, that it abduceth the Iron from it, by the ſame reaſon, that a Leſs Loadſtone ſnatcheth a Needle from a Great one. And thus much concerning the *Attractive* Faculty of the Loadſtone; both according to the moſt conſiderable Doctrine of the Ancients, and the more exact Theory of the Moderns.

Sect. II.

Art. 1. The *Method*, and *Contents* of the Section.

TO enquire the Reaſon, therefore, of the other General Propriepriety of Magnetiques, their DIRECTION, or Converſion of their Poles to North and South; is all the remainder of our præſent Deſign: which that we may accompliſh with as much plainneſs and brevity, as the quality of the Argument will admit of; we ſhall obſerve the ſame advantageous Method of Diſquiſition as we have done in the former, touching the Cauſes and Wayes of Magnetique Attraction, reducing all the obſervations of the Moderns, of the *Direction*, *Declination*, and *Inclination* of the Loadſtone, and other Magnetical bodies, to certain Heads, and diſpoſing them according to their order of ſubalternate dependency.

Art. 2. Affinity of the Loadſtone and Iron.

The FIRST OBSERVABLE is; *that the Loadſtone and Iron are Twinns in their Generation, and of ſo great Affinity in their Natures*, that Dr. *Gilbert* might juſtly ſay, *that a Loadſtone is Iron Crude, and Iron a Loadſtone excocted*: For they are for the moſt part found lodged together in the ſame ſubterraneons bed; as the experience of all ſuch as are converſant about Iron Mines in Germany, Italy, France, England, and moſt other Countries, doth every day demonſtrate.

And that is the moſt probable Cauſe, that can be given, why Loadſtones generally are ſo much the more Vigorous and perfect, by how much deeper in the Veins of Iron Mines they are digged. There is, indeed, a report diffuſed not only among the People, but alſo ſome of the higheſt form of Learned Writers, and chiefly derived from the authority of *Strabo*; that in the Weſtern Ocean are certain vaſt *Magnetick Rocks*, which drawing Ships that ſail near them (by reaſon of the Iron pinns, wherewith their ribbs and plancks are faſtned, and held together)

gether) with irreſiſtible violence and impetuoſity, ſplit them in pieces, or extracting the Iron pinns, carry them like arrowes flying to a Butt, through the aer: But, the light of Navigation hath long ſince diſcovered this ſtory to be as highly Romantique, as the Enchanted Caſtles of our Knights Errant, or the moſt abſurd of Sir *John Mandevils* Fables; and herein we may ſay of *Strabo*, as *Lucian* of the Indian Hiſtory of *Cteſias* the Cnidian, Phyſician to *Artaxerxes* King of Perſia, *ſcripſit de ijs, quæ nec ipſe vidit unquam, neque ex ullius ſermone audivit.*

Art. 3. The *Loadſtone* conforms it ſelf, in all reſpects, to the *Terreſtrial Globe*; as a *Needle* conforms it ſelf to the *Loadſtone*.

The SECOND; *That the Loadſtone ſeems not only to have all the Conditions of the Terreſtrial Globe, but alſo to imitate the poſitional reſpects thereof, conforming it ſelf exactly unto it.* For, as the Terraqueous Globe hath *Two Poles*, by which it owns a reſpect to the Poles of the Heavens, the one *Boreal*, the other *Auſtral*: ſo likewiſe hath the Loadſtone two contrary Poles, alwayes diſcoverable in the oppoſite parts or extremes thereof, eſpecially if it be turned into a ſphere. And, as the Globe of the Earth hath an *Æquator*, *Parallels* and *Meridians*; ſo hath the Loadſtone: as may be demonſtrated to the eye, by applying a ſmall Steel Needle thereunto; for, at either of its Poles, the Needle ſhall be erected perpendicularly, and lye in the ſame line with its Axis; but at any of the intermediate Spaces, or Parallels, it ſhall be neither plainly erected, nor plainly lye along, but obſerve an oblique ſituation, and more or leſs oblique, according to the variety of the Parallels; and at the middle interſtice, or Æquator, it ſhall diſpoſe it ſelf in conformity to the ductus of the Meridian, and fix in a poſition parallel to the Axis of the Loadſtone. That a Loadſtone doth accommodate it ſelf exactly to the Earth, as a Needle doth accommodate it ſelf to the Loadſtone; is evinced from this eaſie Experiment. If you ſuſpend a Loadſtone (whoſe Poles you have formerly diſcovered, and noted with the Characters, *N. S.*) in calme aer, or ſet it floating at liberty in a veſſel of Quickſilver, or a ſmall Skiff of Cork ſwimming upon Water, that ſo it may freely perform the office of its nature; you ſhall obſerve it continually to move it ſelf from ſide to ſide, and ſuffer alternate Vibrations or acceſſes and receſſes, till it hath ſo diſpoſed it ſelf according to the Meridian, as that one of its Poles, viz. that marked with *N.* ſhall point to the North, and the other, upon which *S.* is inſcribed, to the South. Nor that only, but, foraſmuch as *England* is ſituate near the North of the Earth, and ſo hath the North pole ſomewhat demerſed or depreſſed below the horizon, nearer than the South Pole of the Earth: therefore doth not the Loadſtone keep up both its Poles in a level or perfectly horizontal poſition, but depreſſeth that pole which affects the N, ſomewhat below the plane of the horizon, as much as it can, directing the ſame to the *N.* pole of the Earth. Farther, being it is commonly obſerved, that this Depreſſion (ſome call it the DECLINATION, others the INCLINATION) of the *N.* pole of the Loadſtone, or point of an excited Needle, is ſo much the greater, by how much nearer the ſtone or needle is brought to the Boreal part of the Earth; ſo much leſs, by how much nearer to the Æquator: therefore may we conclude

clude, that a Loadſtone, being removed, in the ſame poſition of freedome, from the Æquator by degrees to each of the Earths poles, would more and more depreſs or decline its Boreal pole, by how much it ſhould come nearer and nearer to the Boreal pole of the Earth; and on the otherſide of the Æquator, more and more decline its Auſtral pole to the Auſtral pole of the Earth, by how much nearer it did approach the ſame; nor could it lye with both poles above the horizon at once, in any part of the Earth, but upon the Æquator, and at either of the Poles of the Earth, the Axis of the ſtone would make one with the Axis of the Earth.

Art. 4. *Iron obtains a Verticity*, not only from the Loadſtone, by Affriction, or Aſpiration; but alſo from the *Earth* it ſelf: and that according to the laws of *Poſition.*

The THIRD; That Iron acquireth a Verticity not only from the touch or affriction of a Loadſtone, but alſo from its meer ſituation in, upon, or above the Earth, in conformity to the poles thereof. For, all Iron barrs, that have long remained in Windows, Grates, &c. in a poſition polary, or North and South; if you ſuſpend them in æquilibrio by lines in the aer, ſo as they may move themſelves freely, according to the inclination of their Virtue received from the Earth, will make ſeveral diadroms hither and thither, and reſt not untill they have converted to the North that extreme, which in their former diuturne poſition regarded the North, and that to the South, which formerly reſpected the South: and having recovered this their Cognation, they ſhall fixe in a Meridional poſture as exactly as the Loadſtone it ſelf, or a Magnetified Needle.

To experiment this, the moſt eaſie way is to offer, at convenient diſtance, a Magnetick Dial, or Marriners Compaſs, to the extrems of an Iron barr, that hath long layn *N* and *S*: for, then may you ſoon obſerve the Needle or Verſory freely equilibrated therein to be drawn in that point, which reſpecteth the North, by that extreme of the barr, which is Auſtralized, and, on the contrary, the South point of the Needle to be drawn by that extreme of the barr, which is Borealized. This Vertical imprægnation of Iron meerly by the Earth, is alſo evidenced from hence; that Iron barrs made red hot, and then ſet to cool in a Meridional poſition, do acquire the like polary Cognation, and being either at liberty of converſion ſuſpended by ſmall Chords in the aer, or ſet floating in ſmall boats of Cork, or applyed to the Needle of a Pixis Nautica, immediately diſcover the ſame.

This being moſt manifeſt, why may not our Marriners, in defect of a Loadſtone, make a Needle or Fly for their Chard, of ſimple Iron alone; ſince, if it hath layn in a Meridional ſituation above the earth, or been extinguiſhed according to the ſame lawes of poſition, it will bear and demonſtrate as ſtrong an affection to the poles of the Earth, as a Needle invigorated by a Loadſtone, nor ſhall the Depreſſion or Declination of the one, in each degree of remove from the Æquator toward either pole, be leſs or greater than that of the other.

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Art. 5. One and the ſame Nature, in common to the *Earth*, *Loadſtone* and *Iron*.

The FOURTH; that inſomuch as both the Loadſtone and Iron have ſo neer a cognation to the Earth, and conformity of ſituation to the parts of it: nothing, certainly, can ſeeme more conſentaneous, than that they both hold one and the ſame nature in common with the Earth, at leaſt with the Internall parts, or Kernell thereof; but yet with this difference, that Iron, being a part of the Earth very much altered from its orginall conſtitution by the activity of its ſeminall principle, cannot therefore ſo eaſily manifeſt its extraction, or prove it ſelf to be the genuine production and part thereof, without præcedent Repurgation, and Excitation, or freſh Animation from the Effluviums of the Earth; but a Loadſtone, having not undergon the like mutations from concoction, and ſo remaining nearer allied to the Earth, doth retain a more lively tincture of its polary faculty, and by the evidence of ſpontaneous Direction demonſtrate its Verticity to be purely native, and it ſelf by conſequence, to be onely a divided part, or legitimate iſſue of the Earth. Further, from hence, that the Loadſtone and the Terreſtriall Globe have both one and the ſame power, though in different proportions, of imprǣgnating Iron with a polary affection, impreſſing one and the ſame faculty thereupon; it is juſtly inferrible, that the Loadſtone, not onely in reſpect of other Conditions wherein it reſembleth the Earth, but alſo, and in chief of this noble Efficacy of invigorating and renovating the magneticall quality of Iron, may well be accounted (as the Father of Magnetique Philoſophy, *Dr. Gilbert* hath named it) Μικρογῆ, *Terrella*, the Globe of Earth in epitome; and that the Earth it ſelf may be reputed *Ingens Magnes*, a Great Loadſtone. Though, in truth, the Earth may challenge the title of a Great Magnet by another right, though ſomewhat leſs evident; and that is its Attraction of all terrene bodies in direct lines to it ſelf (as we have formerly made moſt veriſimilous, in our Chapt. of Gravity and Levity) by the ſame way and inſtruments, as the Loadſtone attracteth Iron. And though it cannot be denied, that the Cortex of the Terreſtriall Globe, which may be many miles thick, is variouſly interſperſed with waters, Vapours, exhralations, ſtones, metalls, metalline juices, and divers other diſſimilar and unmagneticall bodies: yet notwithſtanding may we juſtly conceive, that the *Nucleus* Kernell or interior part of the Earth is a ſubſtance wholly Magneticall, and that many Veins or branches thereof, being derived unto the exterior parts, are thoſe very ſubterraneous Veins from which by effoſſion Loadſtones are extracted. Eſpecially ſince nature doth invite us to this conception by certain clear evidences not onely in Iron, which may be digged out of moſt places in the Earth, but alſo in moſt Argillous and Arenaceous Concretions; all which are found to be endowed with a certain, though obſcure Polary inclination, as appears in Bricks and Tiles, that have a long time enjoyed a meridionall ſituation, regarding the N. with one extreme, and the S. with the other, or been made red hot and afterward cooled

north and ſouth, or perpendicularly erected, as hath been ſaid of Iron barrs.

Art. 6. The Earth, impræ̃gnating Iron with a Polary Affection, doth cauſe therein a *Locall Immutation* of its inſenſible particles.

The FIFTH; It being then moſt certain, that Iron obtaines a magneticall Verticity, or faculty of ſelf-direction to the poles of the earth, meerly either from its long ſituation, or refrigeration after ignition, in a poſition reſpective thereunto: we may be almoſt as certain, that this Affection ariſeth to the Iron from no other but a *Locall immutation, or change of poſition of its inſenſible particles*, ſolely and immediately cauſed by the magneticall Aporrhæa's of the Earth invading and pervading it. When we obſerve the Fire by ſenſible degrees embowing or incurvating a peice of wood, held neer it, how can we better ſatisfy our ſelves concerning the cauſe and manner of that ſenſible alteration of the figure of the wood, then by conceiving, that its inſenſible particles are all of them ſo commoved by the Atoms of Fire immitted into it ſubſtance, as that ſome of them are conſociated which were formerly at diſtance, and others diſſociated, which were formerly contingent, all being inverted and ſo changing their priſtine ſituation, and obtaining a new poſition, or locall direction, much different from their former? And, when we obſerve a rod of Iron, freſhly infected with the Polary virtue of the Earth, to put on a certain ſpontaneous inclination in its extremes, and convert it ſelf exactly according to the meridian, and with a kind of humble homage ſalute that pole of its late inſpirer, from whence it received the ſtrongeſt influence: how can we more reaſonably explain the reaſon of that effect, than by conceaving, that upon the immiſſion of the Earths magneticall Rayes into the ſubſtance of the Iron, the inſenſible particles thereof are ſo commoved, diſtructed, inverted, and turned about, as that they all are diſpoſed into a new poſture, and acquire a new locall reſpect or Direction; according to which they become as it were reinnimated with a tendency, not the ſame way, but another much different, and (when the cognation of their extremes are varied by an inverted ignition and refrigeration) quite contrary to that, whither they tended before this mutation of their poſition and reſpect? This Conjecture may ſeem ſomewhat the more happy from hence; that a barr of Iron, when made red hot, doth acquire this Polary Direction in a very few minutes of time: but being kept cold, it requires many years ſituation North and South, to its impræ̃gnation with the like virtue; a ſufficient manifeſt, that the particles of the Iron being, by the ſubingreſſion of the Atoms of Fire among them, reduced to a greater laxity of contexture, are more eaſily commoved and inverted by, and more expeditely conforme themſelves unto the diſpoſition of the magnetique influence of the Earth. When a red hot barr of Iron is cooled, not in a meridian poſition to the poles of the Earth, but tranſverſly or equinoctionally; why doth it not contract to it ſelf the like verticall diſpoſition? doubtleſs, the beſt reaſon that can be given for it, is this; that the inſenſible particles of it are

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not converted, nor their ſituation varied ſo much in the one poſition of the whole maſs, as in the other: the magneticall Rayes of the Earth invading the ſubſtance of the Iron in indirect and ſo leſs potent lines. Likewiſe, if the ſame barr of Iron, after it hath imbibed a Verticity, be again heated and coold in a contrary poſition; what reaſon can be aſſigned to the change of the Southern Verticity into a Northern, and its Northern into a Southern, by the contrary obverſion of its ends: unleſs this, that the particles of the Iron doe thereby ſuffer a freſh converſion, and quite contrary diſpoſition; no otherwiſe than thoſe of a piece of wood, when it is incurvated by the fire according as this or that ſide is obverted thereunto?

Art. 7. The Loadſtone doth the ſame.

The SIXTH; foraſmuch as Iron doth derive the ſame Verticity or Direction from its Affriction againſt a Loadſtone; as it doth from the magneticall influence of the Earth, when poſited reſpectively to its poles: it appears neceſſary, that it doth ſuffer the ſame Locall Immutation of its inſenſible particles, from the efficacy of the magneticall rayes of the Loadſtone, as from thoſe of the Earth; eſpecially ſince we cannot comprehend, how a Body ſhould acquire a ſtrong propenſion or tendency to a new place, without ſome generall Immutation, and that a Locall one too, of all its component particles. The ſtrength of this our conception conſiſteth chiefly in this; that after a rod or needle of Iron hath contracted a ſprightly Verticity from a Loadſtone, by being rubbed thereupon from the middle toward the ends, it doth inſtantly loſe it again, if it be rubbed upon the ſame, or any other Loadſtone, the oppoſite way, or from either end toward the middle. For, how can it be imagined, that a right-hand ſtroak of a knife upon a Loadſtone ſhould deſtroy that polary Faculty, which it had obtained from a left-hand ſtroak upon the ſame; unleſs from hence, that the inſenſible particles of the blade of the knife, were turned one way by the former affriction, and reduced again to their former naturall ſituation by the latter? It ſeems to be the ſame, in proportion, as when the ears of Corn in a field are blown toward the South by the North wind, and ſuddainly blown from the South toward the North by the South wind. Nor doth Iron, after its excitement retain any of the magneticall Atoms immitted into it either from the Earth, or a Magnet; but, ſuffers only an immutation of its inſenſible particles, which ſufficeth to its polary reſpect a long time after: for, a Needle is no whit heavier after its invigoration by a Loadſtone, than before, as *Merſennus* and *Gaſſendus* together experimented, in ſuch a *Zygoſtata* or Ballance, wherewith Jewellers are to weigh Pearles and Diamonds; which is ſo exact, that the ninety-ſixth part above four thouſand of a grain, will turn it either way.

Art. 8. The Magnetique Virtue, a *Corporeal* Efflux.

The SEVENTH; that the Virtue immitted into Iron, either from the Earth it ſelf, or a Loadſtone, is no ſimple, or immateriall Quality, as both *Gilbert* and *Grandamicus* earneſtly contend; but a certain *Corporeal Efflux*, or Fluor, conſiſting of inſenſible bodies, or particles,

which introduce upon the particles of Iron the ſame Diſpoſition, and Local reſpect, as themſelves have.

For (1) That an Immutation is cauſed in the particles of Iron, as well by the influence, or Magnetical rayes of the Loadſtone (which doth alſo invigorate Iron, at ſome diſtance, though not ſo powerfully, as by immediate contact, or affriction) as of thoſe tranſmitted from the Earth; we have already declared to be not only veriſimilous, but abſolutely neceſſary: & that nothing ſhould yet be derived unto the Iron from them; as the Inſtrument of that Immutation; is openly repugnant to the Fundamental Laws of all Phyſical activity, ſince nothing can act upon a diſtant ſubject but by ſome Inſtrument, either continued or tranſmitted.

(2) What is immitted into the Iron from the Earth and Loadſtone, cannot be any naked Quality, or Accident without ſubſtance; becauſe, what wants ſubſtance, muſt alſo want all Activity.

(3) The Materiality of the Magnetique Virtue is inferrible likewiſe from hence, that it decayes in progreſs of time (as all Odours do) and is irreparably deſtroyed by fire, in a few minutes, and is capable of Rarity and Denſity (whence it is more potent near at hand, than at the extremes of it ſphere) all which are the proper and incommunicable Attributes of Corporiety.

(4) Inſomuch as it changeth the particles of Iron, that have Figure and Situation; therefore muſt it ſelf conſiſt of particles alſo, and ſuch as are in figure and ſituation conſimilar to thoſe of Iron: no leſs being aſſumable from the Effect even now mentioned, *viz.* the Ablation of that Verticity, by a right hand draught of a Needle upon a Loadſtone, which it lately acquired from it, by a left hand one. Nor, indeed, doth the Loadſtone ſeem to act upon Iron, otherwiſe than as a Comb doth upon wool or hair; for as a Comb being drawn through Wool, one way, doth convert and diſpoſe the hairs thereof accordingly, and drawn præpoſterouſly or the contrary way, doth invert & præpoſter the former ductus of the hairs: ſo do the Magnetical Rayes invading and pervading the ſubſtance of Iron, one way, diſpoſe all the inſenſible particles thereof according to their own ductus, toward the ſame way; and immitted into it the quite contrary way, they reduce the particles to their native ſituation and local reſpect; and ſo the formerly imprinted Verticity comes to be wholly obliterated.

Art. 9. Contrary *Objections*, & their *Solutions.*

OBJECTED, we confeſs it may be; that the Incorporiety, or Immateriality of the Loadſtones Virtue ſeems inferrible from hence, that it moſt expeditely penetrateth and paſſeth through many bodies of eminent ſolidity, and eſpecial Marble: (2) That it is (Soul-like) total in the total Loadſtone, and total in every part thereof: ſeeing that into how many ſenſible pieces ſoever a Loadſtone is broken or cut, yet ſtill doth the Virtue remain entire in every one of thoſe pieces, and there inſtantly ſpring up in each ſingle fragment, two contrary Poles, an Axis, Æquator, Meridians and Parallels.

But,

But, as to the *ſubtility of Particles and Pores* in Concretions, our Book is even ſurcharged with diſcourſes upon that ſubject, in the Generall: ſo that notwithſtanding the firſt objection, we may adhære to our former Conception, that the particles flowing from the Earth and Loadſtone, are of ſuch ſuperlative Tenuity, as without impediment to penetrate and permeate the moſt compact and ſolid Concretions, and ſpecially Marble, whoſe ſmall pores may be more accommodate to the figures of the magnetick Atoms, and ſo more fit for their tranſmiſſion, than thoſe of divers other bodies much inferior to it in compactneſs and ſolidity. And being we have the oath of our ſenſe, that the Atoms of Fire doe inſtantly find out many inlets or pores in the body of Marble, by which they inſinuate themſelves into its centrall parts, and ſo not only calefie the whole maſs or ſubſtance thereof, but reduce it ſuddainly into a brittle Calx: why ſhould we not concede, that the Magnetick Atoms may likewiſe find out convenient inlets or pores in the ſame, and by them nimbly pervade the whole maſs; and that with ſo much more of eaſe and expedition, by how much more ſubtile and active they are, than thoſe of Fire? True it is, that we can diſcerne no ſuch Particles flowing from magneticks, no ſuch Pores in Marble, but how great the Dulneſs or Groſneſs of our ſenſes is, comparatively to the ineffable ſubtility of many of Natures Inſtruments, by which ſhe bringeth admirable Effects to paſs, we need not here rehearſe. (2) As for the other Argument deſumed from the *Fruſtulation* of a Loadſtone, we Anſwer; that the ſingle Virtues of the ſingle fragments, are nothing elſe but ſo many Parts of the Totall Virtue: nor being taken ſingularly, are they equally potent with the whole; only they are like the Totall, becauſe in the whole Loadſtone they follow the ductus or tract of its Fibres, that run parallel each to other, and conjoyn their forces with that Fibre, which being in the middle, ſtands for the Axis to all the reſt. But, in each Fragment, they follow the ſame ductus or Grain of the Fibres, and one Fibre muſt ſtill be in the middle: which becomes an Axis, and that to which all the circumſtant ones confer and unite their forces.

Art. 10. A Paralleliſme of the *Magnetique Virtue*, and the *Vegetative Faculty* of Plants.

The EIGHTH; that the Magnetick Virtue, both exiſtent in the Loadſtone, and transfuſed into Iron, ſeems by a lively Analogy, to reſemble the *Vegetative Faculty* or *ſoul* of a *Plant*; not only in reſpect of the Corroboration of the force of its median Fibre, or Axis, by the conference of the forces of all the circumſtant ones thereupon, as the centrall parts of a Plant are corroborated by the circumambient: but alſo, and principally, in reſpect of the *ſituation*, *Ductus*, *or Grain of its Fibres*; which run *meridionally*, as thoſe in Plants perpendicularly, or upward from the roots to the tops of the ſpriggs. For, as in the Inciſion or Engraffing of the ſhoot of one tree, into the trunck or ſtock of another, the Gardiner muſt obſerve to inſert the lower extreme of the ſhoot, into a cleft in the upper extreme of the ſtock, as that from whence the nutritive ſap and vegetative influence are to be derived unto it; becauſe, if the ſhoot were inverted, and its upper extreme inſerted into the ſtock, it would neceſſarily wither and die, as being in that præpoſterous poſition made uncapable of the influx of the Alimentary juice and vitall Faculty, both which come from the root upward to the branches, and

and cannot deſcend again from them to the root: exactly ſo, when we would diſpoſe a Loadſtone in conformity of ſituation to the Earth, from which it hath been cut off, or to another Loadſtone, a quondam part of it ſelf; 'tis not every way of Appoſition, that will be convenient, but only that, when it is diſpoſed in a direct line, reſpondent to the ſame Ductus or ſituation of its Fibres, according to which it was continued to the Earth, before its ſeparation. Nor is this meer Conjecture, but a truth as firme as the Earth it ſelf, and as plain as ſenſe can make it; it being conſtantly obſerved, that what ſituation a Loadſtone had in its Matrix, or minerall bed, the very ſame it ſhall ſtrongly affect, and ſtrictly obſerve ever after, at leaſt, while it is a Loadſtone, i. e. untill time or Fire have deſtroyed its Verticity. And, as for the Uſe thereof; it is ſo fruitfull, as to yield us the moſt probable Reaſon in Generall, for ſundry the moſt obſcure among all Magneticall Apparences.

Art. 11. Why Poles of the *ſame* reſpect & name, are *Enemies:* and thoſe of a *Contrary* reſpect & name, *Friends.*

(1) Foraſmuch as the Loadſtone ever affects its native ſituation, and that its Northern part did, while it remained in its matrix, adhære to the Southern parts of the ſame magnetique vein, that lay more North, and its Southern part did adhære to the Northern part of the magnetick vein, that lay more South: therefore is it, that the North pole of a Loadſtone doth never affect an union with the North pole of the earth, nor its South pole direct to the South pole of the Earth: but quite contrary, its North pole converts to the South, and its South to the North. So that whenever you obſerve a Loadſtone, freely ſwimming in a boate of Cork, to convert or decline one of its poles to the North of the Earth; you may aſſure your ſelf, that that is the South pole of the Loadſtone: and è contra.

Art. 12. When a Magnet is diſſected into two pieces, why the *Boreal* part of the one half, declines Conjunction with the *Boreall* part of the other; and the *Auſtrall* of one with the *Auſtrall* of the other.

(2) From the ſame and no other Cauſe is it alſo, that when a Magnet is diſſected or broken into two pieces, and ſo two new poles created in each piece; the Boreall pole of the one half ſhall never admit Coition with the Boreall pole of the other, nor the Auſtrall extreme of the one fragment affect conjunction with the Auſtrall extreme of the the other: but contrariwiſe, the Auſtrall end ſhall ſeptentrionate, and the ſeptentrionall Auſtralize. The ſame alſo happens, whenever any two Loadſtones are applied each to other; the Cauſe being Generall, viz. the Native *Ductus* or Grain of the Magnetique Fibres: which is inverted, whenever the Boreall part of a Loadſtone is applied to the Boreall part of the Earth, or of another Loadſtone; or the Meridionall part of a Loadſtone be converted to the meridionall part of the Earth of another Loadſtone; as the Ductus of the Fibres in a ſhoot of a Plant is inverted, when the upper extreme thereof is inſerted into the upper part of a ſtock. This conſidered, when we obſerve the Animated Needle of a Mariners Compaſs, freely converting it ſelf round, upon the pin, whereon it is æquilibrated; that end, which directeth to the North pole of the Earth, muſt be the South point of the Needle, and viceverſally, that muſt be the North cuſpis of the Needle, which confronteth the South of the Earth. And; when præſent a Loadſtone to a magnetified Verſory, that part of the Loadſtone muſt be the North pole, to which the South cuſpis of the Needle comes; and

and that, to which the North point of the Needle approaches; muſt be the South of the Loadſtone. The ſame alſo may be concluded; of the extremes of Irons, when a Loadſtone is applied unto them; for, that part of an Iron barr, which laied meridionally, hath reſpected the North, muſt have been ſpirited by the Southern influence of the Earth; and è contra: and among our Fire Irons, the upper end muſt have imbibed the Northern influence of the Earth, and the Lower the Southern; contraty to the aſſertion of ſome of our Magneticall Philoſophers.

Art. 13. The Fibres of the Earth extend from Pole to Pole; and that may be the Cauſe of the firme *Cohæſion* of all its Parts, conſpiring to conſerve its Sphericall Figure.

The NINTH; the Analogy of the Earth to the Loadſtone, and other magnetically inſpired bodies, being ſo great, and the Cauſe thereof ſo little obſcure; it may ſeem a juſtifiable inference, *That the Terrieſtriall Globe doth inwardly conſiſt of certain continued Fibres, running along from North to South*, or from South to North, in one uninterrupted ductus: and conſequently, that ſince the middle Fibre is as it were the Axis, whoſe oppoſite extremes make the two Poles, in caſe the whole Earth could be divided into two or more great parts, there would inſtantly reſult in every part or diviſion, a ſpecial Axis, two ſpeciall Poles, a ſpeciall Æquator, and all other conditions as formerly in the whole Globe; ſo that the ſeptentrionall part of one piece would conjoin it ſelf to the Auſtrine part of another, and the ſeptentrionall parts reciprocally avert themſelves each from other, as the parts of a Loadſtone. And this we may underſtand to be that mighty and ſo long enquired Cauſe, *why all the parts of the Terreſtriall Globe do ſo firmly cohære, and conſerve the primitive Figure*; the Cohæſion, Attractive Virtue, conſtant Direction, and ſpontaneous Verticity of all its genuine parts, all whoſe Southern Fibres doe magnetically, or individually conforme and conjoyn themſelves to the Northern, and their Northern to the Southern, being the neceſſary Cauſes of that Firmneſs, and conſtancy of Figure. Impoſſible, we confeſs, it is, to obtain any ocular Experiment of this conſtitution of the Earths internall Fibres; the very Cortex of the Earth extending ſome miles in profundity: but yet we deſume a reaſonable Conjecture thereof, as well from the great ſimilitude of effects wrought by the Earth and other Magneticks, as the Experience of Miners, who frequently obſerve, and conſtantly affirme, that the Veins of ſubterraneous Rocks, from whoſe chinks they dig Iron oare, doe allwayes tend from South to North; and that the Veins of eminent Rocks, which make the Giant Mountains upon the face of the Earth, have generally the ſame Direction. And though there are ſome Rowes or Tracts of Mountains, that run from Eaſt to Weſt, or are of oblique ſituation; yet are there alwayes ſome conſiderable interciſures among them, from South to North: ſo that that can be no ſufficient argument, that the interior Fibres of the Earth, which are truely and entirely magneticall, and ſubjacent under thoſe Mountainous rocks, doe not lye in a meridionall poſition, or conforme to the Axis of the Earth.

Art. 14. Reaſon of Magneticall *Variation*, in divers climates and places.

The TENTH; that ſince the obſervations of Miners aſcertain us, that the Ranges or Tracts of Rocks, in the Cortex or acceſſible part of the Terreſtriall Globe, do for the moſt obſerve a præciſely Meridionall

dionall ſituation, and tend from South to North, and ſometimes (i.e. in ſome places) deflect toward the Eaſt and Weſt, with leſs and greater obliquity; and that our Reaſon may from thence, and the ſimilitude of the Earth and Loadſtone, naturally extract a Conjecture, that the Fibres of the Earths Kernell or inacceſſible parts, though for the moſt they tend præciſely from the South to the North; may yet in many places more and leſs Deflect toward the Eaſt and Weſt: we need no longer perplex our minds with enquiring, *Why all Magnetiques, and eſpecially the Verſory or Needle of the Sea-mans Compaſs, being horizontally æquilibrated, doe in ſome places point directly to the North and South, and in others deflect toward the Eaſt and Weſt, with more and leſs of obliquity*; which Navigators call (for diſtinction of it from the Depreſſion, or Inclination, formerly explicated) the VARIATION of the Loadſtone, or Needle. From the Mariners Tables (though they are full of diſcord, as to the degrees of the Needles Deflection or Variation from the true Meridian, in ſeverall parts of the Earth) we learn, that the Needle doth exactly conforme it ſelf to the Axis of its great Inſpirer, the Earth, without any ſenſible deflection at all, in the Iland Corvus, one of the Azores, in the Iland of the Trinity, in the promontory of the Needles, neer the Cape of Goodhope, in the Fretum Herculeum, Syllæum, the Thracian Boſphorus, the Iland Malta, at Vienna, and divers other places. But in others, and particularly in England, it delines ſomewhat toward the Eaſt, yet with conſiderable diverſity, ſo that in ſome countries its Variation exceeds not 1. 2. or 3. degrees at moſt, and in others it amounts to no leſs than 40, or 50. Again there are other meridians, in which the Declination of the Compaſs is toward the Weſt; as frequently upon the Orientall coaſt of the Northern America; on the Occidentall coaſt of Nova Zembla, and Goa; the Eaſtern ſide of Africa; in our Mediterrane, at Naples, and ſundry other places. Nay, oftentimes in the ſame Meridian, and in various degrees of Latitude, it hath been obſerved, that the Needle doth not vary at all, and vary both Eaſtward and Weſtward; for, though in the Iland Corvus the Declination be inſenſible, where the Latitude is of about 40 degrees; yet on this ſide of it, in the Latitude of 20 degrees the Declination amounts to 12 degrees Eaſtward: and beyond it, in the Latitude of 46 degrees the Declination toward the Weſt, ariſeth to 8 degrees; and farther off, in the Latitude of 55 the Weſtward Declination equalls 24 degrees. So alſo, in the Iland Elba, at one promontory, the Needle deviates toward the Eaſt only 5 degrees; at another promontory, 8; and at a third, as high as 20. which being duely perpended, doth ſoon detect the unadviſedneſs and incircumſpection of Thoſe, who have referred the Declination of the Magnet to the Deviation of the Aſteriſme, Urſa Minor, or Pole of the Ecliptick from the poles of the World; and attempted to explain it by imagining ſome certain Magnetick Rocks, which being ſituate on the Eaſt ſide of the Artick Pole of the Earth, conſtitute a ſpeciall Magnetick Pole, or that whereunto the Verſory Needle is generally deflected. Much more happy than this, was the invention of *Dr. Gilbert*; who ſuppoſing that the Magnetique Virtue of the Earth was more powerſully impreſſed upon the Needle from the Extant or Eminent parts thereof, and eſpecially in great Continents: makes out the cauſe of the Magnets in-

direction,

"direction, or Variation, thus. If the Needle be placed in the middle "betwixt two vast Continents, as in the Azores, which have Europe "to the East, and America to the West; it suffers no sensible Distra-"ction to either part: but, if it be brought nearer to the Continent of "Europe and Asia, it must be invited and deflected toward the East; "and nearer to the Continent of America, it shall deviate as much to-"ward the West. For the same Cause also, upon the Western coast of "Africa the Declination is toward the East; and on the Orientall, to-"ward the West: and betwixt them both, as at the Cape of Good-hope "none at all. And yet this subtle Theory of *Dr. Gilbert* is more then suspected of Imperfection: For, since that, on the Western coast of America, and of Goa, the Declination of the Needle is Westward; and not onely on the Orientall side of the Meridionall America, and chiefly about the streights of Megellan, but also on the Orientall side of the Septentrionall America, as at Virginia, the Declination teaseth not to be, in the same manner, toward the East; absolutely contrary to *His* Hypothesis: therefore hath the incomparable Father, *Kircher*, to his own immortall honour, and our greater satisfaction, advised us, to leave the Attraction of adjacent Continents, and have recourse onely to the divers Positions of the interior Magneticall Fibres of the Earth, over which the Magnet, or Needle stands; considering that they have their situation sometimes exquisitely Meridionall, sometimes more and less oblique, and tend in some places in longer, in others in shorter tracts. For, it is no difficult conception; the Virtue of the Earth is impressed upon the Needle from the magneticall Fibres and Veins, that are nearest, i. e. directly subjacent thereunto; and disposed thereby into a situation respective to the Ductus of those perpendicularly subjacent Fibres: so that whatever be the Direction of the Needle; i. e. either without all Declination, or with some, more or less, in one part toward the East, in another toward the contrary pole of the heavens; still may we suppose it to be exactly respondent to the Ductus, or Direction of the Fibres of the Earth, that perpendicularly lye underneath it. Nor is this meerly Petitionary, or excogitated onely for the solution of this grand Magneticall Problem, as the Former of *Gilbert* seems to have been; but founded upon a Parallel *Experiment*: for, if you place severall Barrs of Iron excited, upon the ground, so that one may lye exactly according to the Meridian, and all the rest in severall degrees of obliquity, untill you come almost to make an Æquinoctionall line with one; and then gently and at requisite distance, move an invigorated Needle, equilibrated upon a pin, over them; you shall observe the Direction of it to be varied to more and less obliquity from the Meridian Barr, respectively to the situation of each of the other Barrs, over which it is directly held. Now, if you suppose the Magnetique Fibres of the Earth to have the same Virtue upon the Needle; as, if not much more than the subjacent Iron Barrs have: you have attained the bottome of the Mystery, and that one of the greatest in Nature.

Art. 15. The *Decrement* of Magneticall Variation, in one and the ſame place, in divers years.

The ELEVENTH and laſt; that as the Converſion of the inſpired Needle is not exactly meridionall in all places of the Earth, but ſiding more or leſs toward the Eaſt, in ſome Topicall meridians, and toward the Weſt, in others: ſo alſo *is not the Declination thereof, though in one and the ſame place, conſtant to the ſame degree, at all times, but admits conſiderable Variation, and that in a few years.* For, *Mr. Burrows*, in the year 1580, making an exact obſervation of the quantity of the Needles Declination toward the Eaſt, at Limus, near London, found it to amount to no leſs than 11. degrees 15 minutes: and afterward, in the year 1622. *Mr. Gunter*, at the ſame place, obſerved it to be diminiſhed to onely 6. degrees, and 13 minutes: and *Gellebrand*, in Anno Dom. 1634. in the ſame place, found it to come yet lower, and not to exceed 4 degrees 6 minutes: So that, in the meridian of London, as our Noble Countryman, Sir. *Kenelm Digby* hath well remarked, the Declination of the Needle Eaſtward hath been more Diminiſhed in the latter years than in the former. The like Decreaſe of the Variation of the Needle hath been taken notice of alſo in France, at Paris by *Mercennus*, and at Aix, by *Gaſſendus*. And therefore we may præſume, if the Needles continue, in the ſame manner, and at the ſame rate, to leſſen their Declination, that within a very few years, with us here in England, and other adjacent Countries, they will have no Declination at all toward the Eaſt, and perhaps wheele about toward the Weſt, and every year more and more approach the contrary point of the Æquator.

Art. 16. The *Cauſe* thereof not yet known.

Now, as for the *Cauſe* of this truely ſtupendious Effect of Magneticks; *Grandamicus*, indeed, thinks it beſt ſolved, by charging it onely upon the Errors of obſervation, not upon any Mutation of the Axis of the Earth, which would of neceſſity vary all Cæleſtiall obſervations, no leſs than Magneticall ones: enforcing this His opinion from hence, that the beſt of Aſtronomers are frequently not onely ſubject to, but guilty of great Errors, in their operations to find out the true Generall Meridian Line, of the Altitude of the Sun, of the point of the Heavens that is verticall to this or that place, where they uſe their inſtruments, &c; the certain knowledge of all theſe particulars being abſolutely requiſite to make a true compute of the Degrees of the Needles Variation. But, the Obſervators nominated being all eminent Mathematicians, well underſtanding the ſeverall Cauſes, that might betray them into incertitude, and aſwell how to prævent or avoyd them all; and each one ſetting about the work, with all poſſible care and circumſpection: and it being very improbable, that they all ſhould fall into one and the ſame deluſion: the Ingenious, we hope, will excuſe us, if we incriminate *Grandamicus Himſelf*, with much of temerity, and ſomewhat of injuſtice, in this detractring judgement of His; and aſſent to their more candid and reaſonable one, who referr this ſenſible Declination of Declination in the Magnet, to ſome certain indigenary Cauſe, or Diſpoſition proper to thoſe Places and Countries, where ſuch obſervations were made. But, what *indigenary and particular Diſpoſition* that is, which ſhould thus vary the Magneticall Variation, in the intervall of a few years; is a Problem indeed, and ſuch as ſeems reſerved for the expoſion of Elias. *Kircher* and *Gaſſendus*,

dus, we acknowledge, have attempted moſt laudably, in ſuppoſing the Magneticall Fibres, that lye more diſtant from the Axis of the Earth, or neerer to the ſuperfice thereof, not to be ſo firmely cohærent each to other, but that they may be emoved, evolved, and ſeparated, by ſome ſubterraneous Cauſe or other, and ſo exchange their more oblique, for a leſs oblique, and at length for an abſolutely direct or truely meridionall ſituation; as the Fibres of the Muſcles of Animalls are obſerved ſometimes to ſuffer a certain Revulſion, or change of ſituation, under the skin, for ſeverall Cauſes: and that this Locomotion and Decrement of obliquity of the ſuperficiall magnetick Fibres of the Earth, may be the ſole Cauſe of the like Decrement of obliquity, or Declination of the Needle, in one and the ſame place, in divers years. But, foraſmuch as this Suppoſition is irreconcileable to our *Ninth obſervable* præcedent, touching the Cauſe of the firme Cohæſion of the parts of the Earth, and the Conſtancy of its Sphæricall Figure, from thence reſulting; and that neither *Kircher* nor *Gaſſendus* tells us, what ſubterraneous Cauſe that ſhould be, which might emove and tranſlate the Magneticall Fibres of the Cortex of the Earth, from a more to a leſs indirect ſituation (which in juſtice they both ought to have done:) we ſhall onely applaud the ingenuity of their Conjecture, and return to our former judgement, That the true Cauſe of the Decrement of the Magneticall Variation is yet in the bottome of *Democritus* Pit; and He, who ſhall be ſo happy to extract it from thence, ſhall have our vote, to have his ſtatue ſet on the right hand of that of *Gilbert*, in the Vatican.

Art. 17. No Magnet hath more than *Two Legitimate* Poles: and the reaſons of *Illegitimate* ones.

There yet remains a Difficulty, which being left unreſolved, is of importance enough to make the intelligent and wary Reader ſomewhat coſtive in his Aſſent even to the chiefeſt and moſt Fundamentall of our Præcedent obſervables, concerning the Reaſon of Magneticall Verticity. And that is, *That ſome Loadſtones have more than Two Poles*. ſuch as that Tripolar one of *Furnerius*, of which both *Kircher* and *Gaſſendus* make ſingular mention.

Concerning this, therefore, we ſay; that in every Loadſtone there are two, and but *two true* and *Legitimate* Poles: and that all others apparent in them, either at the Æquator, or betwixt it and either of the Genuine Poles, are ſpurious or Illegitimate; ariſing either from ſome *Node* or Knot growing laterally on to a Magnet (ſuch as is commonly obſerved to interrupt the direct progreſs of the Fibres; or Grain of Trees, and of ſtones) or from an *irregular* and *horned Figure* of the ſtone it ſelf, in reſpect of either of which the Magnetick Virtue cannot be commodiouſly united at the two Genuine and directly oppoſite Poles, but is diſtracted obliquely to that Prominent Node, or Horn-like Protuberancy. For, if either the Node or horns of a Loadſtone, which cauſe it to have more than two Poles, be artificially cut off, and the remainder of the ſtone be poliſhed; a Needle, or the Filings of ſteel, thereunto applied, ſhall never be perpendicular erected at any part thereof, but onely at the *Artick* and Antarctick points; nor ſhall

the ſtone diſpoſe it ſelf otherwiſe than conformably to the Meridian; both which are the moſt certain Diſcoverers of the true Poles of a Loadſtone. Thoſe Illegitimate Poles, therefore which ſometimes (though very rarely) are found in a Loadſtone, are as it were the oblique and Præternaturall parts of it, obtaining the reaſon of Poles only by Accident. Which yet hinders not, but that many times, from the imperfection of the ſtone, it may come to paſs, that the two Legitimate Poles of the ſame Loadſtone, though exactly poliſhed, and reduced to a perfect Sphere, may not exiſt in the Extremes of its Diametre: for, unleſes the Magnet be Uniforme in ſubſtance and Virtue, the Poles thereof cannot be directly oppoſite each to other.

Art. 18. The Concluſion, Apologetically; and an Advertiſement, that the *Attractive* and *Directive* Actions of Magnetiques, ariſe from *one & the ſame Faculty*; and that they were diſtinguiſhed onely διδασκαλίας χάριν, for convenience of *Doctrine*.

And thus, in a naturall Method, and with as much ſuccinctneſs, as the copious ſubject would beare (according to our engagement) have we enquired into the Cauſes of the Two Generall Faculties of the Loadſtone, the *Attractive* and *Directive*, with the moſt conſiderable Phænomena's ariſing from either, or both of them. Wherein, if we have been ſo happy, as to afford but the leaſt of ſatisfaction to others; we ſhall account it no ſmall content to Ourſelves, and think our ſtudies thereby more than ſufficiently compenſated. If not, we ſhall yet conſolate ourſelves with this; that we are not the Firſt, who have fallen ſhort of the Readers Expectation, in the Diſcuſſion of this ſingularly Abſtruſe Argument: which is a thing ſo highly Admirable, that *Aphrodiſæus* (*initio Problem.*) affirmed the Nature thereof to be underſtood only by *Him*, that created it; and *Galen* (*de therica ad Piſon.*) termed the *Attractive* Virtue thereof wholly *Divine*. To which we ſhall add alſo this; that the Hypotheſis, of the continued *Ductus* of the Magnetick Fibres of the Earth, eſpecially of the Kernell, or Interior. ſubſtance thereof, from the South to the North Pole (upon which we have erected the ſolutions of ſundry great Magneticall Apparences) is ſubject to much leſs of Improbability, than that of *Gilbert* and *Grandamicus*, that the Magnetique Virtue is a *ſimple*, or *Immateriall Quality*; than that of *De's Cartes*, that the Magnetique Aporrhæa's conſiſt of ſtreated or Screw'd Atoms, paſſing through the Earth, by contrary and diverſly figurated inſenſible pores, iſſuing forth at either pole, and wheeling about interchangeably to the oppoſite pole; than that of *Sr. Kenelm Digby*, that the Magnetique ſtreams glide along from either Pole and Hemiſphere of the Earth, by Attraction to the Æquator; or, in truth, than any other hitherto excogitated and divulged.

But, before we put an end to this Chapter; 'tis requiſite to advertiſe you of a Conſiderable, omitted in the beginning of it; which is, that though we aſſumed the Virtue Magnetick to be (in Generall) *Twofold*, *Attractive* and *Directive*; yet is that Diſtinction to be admitted, not in an Abſolute, but *Reſpective* intention, or only (κατ' ἐπίνοιαν) in order to our more diſtinct Comprehenſion of the immediate; and particular Reaſons of ſundry reſpective Magneticall Effects, which otherwiſe muſt have wanted the advantage of order in their conſideration. For, we are fully convinced of the truth of that Aſſertion of *Grandamicus* (*Nova Demonſtrat. Immobilit. Terræ, cap.* 5. *Sect.* 2.) that the *Attraction* and *Direction*, or *Alliciency* and *Polarity* of Magneticks, are cauſed by *one* and the *ſame Faculty*: which being conferred upon them, by the infinite Wiſdome and Goodneſs of the Creator, in order to the Conſervation of

of the Earth, and all its genuine parts, in that poſition in the Uuiverſe, and that diſpoſition among themſelves, in which they are beſt ſupported, and moſt conveniently performe Actions conforme and proper to their Nature; may be yet termed *Attractive*, inſomuch as it *Unites* Magneticall Bodies, violently ſeparated; and *Directive*, inſomuch as it *Diſpoſeth* them in a due and commodious ſituation. And ſo, notwithſtanding the Actions and Motions of Magnetiques ſeem exceeding Various, and in ſome caſes, plainly Contrary; yet are they to be deduced from one ſimple principle, one and the ſame Generall Virtue, and they all may be conveniently explicated by the ſame Common Reaſon.

BOOK

The Fourth Book.

CHAP. I.

OF GENERATION AND CORUPTION.

SECT. I.

THat Nature, or the Common Harmony of the World, is continued by *Changes*, or the Viciſſitudes of Individualls, i. e. the *Production* of ſome, & *Deſtruction* of other Things, determined to this or that particular Species; and that there muſt be one Catholique Matter, of which all things are Elemented, and into which they may be again, by Diſſolution, reduced: are Poſitions, to which all men moſt readily proſtrate their aſſent. But, What that Firſt and Common matter is; How Concretions are Educible out of it; and How Reducible at length into it, after the Privation of their Specificall Formes: are

Art. I. The Introduction.

are Quæstions, whose Beginnings are more easily known, than their ends. However, forasmuch as we have endeavoured, in our immediately foregoing Book, to determine the *First* of them, together with the possible Emergency of all Qualities (whereof either our sense, or Reason can afford us any measure of cognizance) and the Reasons of the Perception of them by Animals, from Atoms, so and so Configurated, and so and so Disposed in Commistion: it now neerly concerns us, to attempt the most hopefull Decision of the *other Two* that so we may not seem to have thus long discoursed of the Principles, and Affections of Compound Bodies, while we remained wholly ignorant of the most probable wayes both of their *Origination* from those Principles, and of their *Reversion* into them again, when they have lost the right of their former Denominations, and suffered to the utmost of their Divisibility.

Art. 2. The proper Notions of *Generation* & *Corruption.*

By the terme, GENERATION, we ought præcisely to understand *that Act of Nature, whereby she produceth a Thing de novo, or gives Being to a Thing, in some certain Genus of Bodies Concrete:* and consequently, by its Contrary, CORRUPTION, *that whereby she Dissolves a Thing, so that thenceforth it ceaseth to be what it was.* For, when Fire, a stone, a Plant, an Animal, or whatever is referrible to any one determinate kind of Bodies Compound, is first produced, or made, and begins to be so, or so Denominated; it is truely said to be Generated: and contrariwise, when a Thing perisheth, and loseth the right of its former Denomination; it is as truely said to be Corrupted. And this is that which *Aristotle* (1. *de Generat* 2.) frequently call's *Generatio* ἁπλὴ καὶ τελεία, Generation *Simple* and *Perfect*; so to prævent that Confusion of Generation with *Alteration*, into which many of his Prædecessors had often fallen, to their own and their Disciples no little disquiet. For, Ἑτεροίωσις, *Alteration* can be accounted a Generation only improperly, or *secundum quid*; forasmuch as by Alteration a Body is not produced *de novo*, but onely acquires some new Quality, or some Accidentary Denomination: and Philosophers accordingly define it to be *Progressionem Corporis ex una qualitate in aliam*, a Progression of a Body from one Quality to another, as when water is changed from cold to hot by fire. Again, every Mutation requires a subject to be Altered; and that subject must be something Compound, complete, and already constituted in some determinate Genus of Beings: But, of Generation strictly accepted the onely subject is the First and Universall matter, which being in it self destitute of all Form *Aristole* doth therefore subtly call *simpliciter Non-ens*, simply, or determinately Nothing; forasmuch as he frequently inculteth, that Generation is made [ἐξ ἁπλῶς μὴ ὄντος] ex *Non ente simpliciter*. Because had He ommitted that adverb *simpliciter*, his Reader might justly have understood *Non ens absolute* Nothing Absolutely; and so have accused him of openly contradicting his own Fundamentall Axiome, *Ex nihilo nihil fieri*, that nothing can be made or generated of Nothing.

This

Art. 3. Various pinions of the Ancient Philosophers, touching the reasonof Generation: and the principall *Authors* of pacti.

This being præmised, to prævent the danger of Æquivocation; we observe First, with *Aristotle* (3. *de cælo* 1.) that among the Ancient Philosophers, *some* held, that Nothing is Generated, nothing Corrupted; as *Parmenides* and *Melissus*: *Others* again, that. All things are Generated and Corrupted; as *Hesiod* and *Heraclitus*. Secondly, that of Those, who admitted Generation, and consequently Corruption; *some* conceived, that Generation is made by the Access of a Form to Matter; and that that Form is a certain New substance, absolutely distinct from that of the Matter, and together with it constituting the Compositum, or whole resulting from the Commistion of Matter and Form: of which sect *Aristotle* Himself deserves to be in the Chair, because in order to his Assertion of this Opinion, He supposeth a Threefold substance, the *Matter*, *Form*, and *Compositum* arising from their Commistion. But, *Others* though they concede, that Generation, indeed, consisteth in the Accession of a Form to Matter; yet will they not allow that Form acceding, to be substantiall, but onely a certain *Accident* or Modification of the Matter it self: so that according to their theory, in Generation there superveneth upon Matter some certain Quality, of such a Condition, as that by reason thereof a Thing obtain's a certain Being in Nature, and acquireth some determinate Denomination, respective to that Genus of Bodies, to which its Nature doth referre it. And in the Catalogue of Philosophers of this persuasion, *Aristotle* nominateth as Principalls, *Empedocles*, *Anaxagoras*, *Democritus*, and *Leucippus*; all which He sharply taxeth of Confounding Generation with Alteration, and of inferring, that aswell Generation as Corruption ariseth, not from the *Transmutation* of Principles, but onely from their [Σύγκρισις & διάκρισις] *Concretion* and *Secretion:* which is not only inconsistent, but contrapugnant to His own great Hypothesis, that the Four Elements, or Catholique Principles of Generation, are so Transmutable, both *secundum substantiam* (at least, according to the Comments of all his modern Expositors) & *secundum Qualitates*, as to their substance and Qualities, as that from their Commistion, Alteration, and Corruption, a certain New and distinct substance doth arise, which is the Form of the Thing so produced. For, having supposed for a Groundwork, that the Four Elements are not the First Principles; it could not stand with his advantage, not to have assumed also, that the Elements may be so Transmuted, as that the more Generall and Common Matter doth still remaine: and that the same, upon the perdition of the Elementary Forms, may put on a New Forme, that is substantiall; and that very thing, by which the resulting or Generated Body is specified, and entituled to such a Denomination. But, as for *Empedocles*, and the rest enumerated (to whom we may add also *Epicurus*) 'tis well known that notwithstanding they all admitted the Four Vulgar Elements, as readily as *Aristotle* Himself, yet would they by no means hear of their *Transmutability* either as to *substance*, or *Qualities*: unanimously decreeing, that in their Commistion each of them is divided into particles most minute, which yet retain the very same substance and qualities, that they had before, as that every particle of Fire doth still retain the substance and quality of Fire, namely Heat; and that every particle of Water doth like-

likewise constantly conserve the substance, and quality of Water, *viz.* Moisture; and so of the other two: so that it is most evident, They would have, that in Generation there is onely a [Σύγκρισις] *Concretion* of the insensible particles of the the 4 Elements, but no Transmutation of any one of them, either with the *Perdition* of their own, or the *Adeption* of a new substantiall Forme; both which are præsumed by *Aristotle*.

Art 4. The two great opinions of the same Philosophers concerning the *manner* of the *Commistion* of of the Common Principles, in Generation; faithfully & briefly stated.

But this great Difficulty, about the Generation of Things from the Commistion of the General Principles, soon loseth it self in a Greater, which concerns the *Manner and Condition of their Commistion*, and whose consideration will best instruct us aswell what is the main Difference among Philosophers, touching this most weighty Theorem, as what opinion can best deserve our Approbation and Assent. Concerning this, therefore, we find two necessary Remarks. (1) That there are Two different Kinds of *Commistion*, whereof the one is, by *Aristotle* (*de Generat.* 1. *cap.* 10.) termed Σύνθεσις, *Composition*, and by others, παράθεσις, *Apposition*: the *other* is called, in the Dialect of the *Stoicks*, Σύγχυσις *Confusion*, and in that of *Galen*, κρᾶσις, *Coalition*, or *Temperation*. The *Former* is when those things, whether Elements, or others, that are mixed together, do not interchangeably penetrate each others parts, so as to be conjoyned *per minima*; but either themselves in the whole, or their parts, onely touch each other superficially: as in the Commistion of the Grains of wheat, Barly, Rye and other Corn. The *Latter*, when the things commixed, are so seemingly united, and concorporated, as that they may be conceived mutually and totally to pervade and penetrate each other, *per minimas partes*, so as that there is no one insensible particle of the whole mixture, which hath not a share of every ingredient; as when Wine and Water (that we may use the Example, aswell as Conception of *Aristotle*) are infused together into the same vessel. Now the *Stoicks* and *Aristotle* are equally earnest to have this *Latter* way, or manner of Commistion, *viz.* Σύγχυσις, *Confusion*, to be that, according to which the Elements or Principles of Bodies are commix't in Generation: But *Empedocles*, *Anaxagoras*, *Democritus*, *Epicurus*, with all their Sectators, allow none but the *Former*, or παράθεσις, *Apposition*; with very solid arguments (among which the easy separability of Wine from Water, either by a sponge, or Cup of Ivie, is not the least) asserting, that the Σύγκρισις of Elements, as also of all other things, is really a meer Σύνθεσις, Composition of their small particles, though apparently, or according to the judgement of sense, it may pass for a Σύγχυσις, or Confusion.

(2) That, when either the Elements themselves, or any other Bodies more Concrete, as Water and Wine, are mixed together; they may reciprocally divide, dissect, and resolve each other into either very small and *insensible* [*moleculæ*] *masses*, which yet are each of them composed of multitudes of Atoms concreted; or most exile particles, i. e. *Atoms* themselves: and where the resolution is only into insensible Masses, there may the Commistion be accounted *Perfect*; but, where the parts of each ingredient

are

are so far resolved, as to be reduced quite down to the first Matter, Atoms, there is the Commistion *most Perfect.*

Now, upon this *Distinction* depends the whole Controversy betwixt *Aristotle* and the *Stoicks*, on one part, and the *Atomists*, on the other, about the Manner of the Commistion of the Common Principles in Generation: *Those* vehemently contending for their totall *Concorporation*, or Unition *per minimas partes*, so that every the most minute particle in the whole mistum, must be of the very same nature with the whole; *These* strongly asserting, that no Mistion of Elements, or Temperation of Principles, goes further than a meer *Apposition*, or *superficiall Contingency* of their several particles, so that the particles of each ingredient must still retain the very same nature they had before commistion, howbeit they may seem to be totally Concorported, or Confused, in regard they are reduced to such Exility, as that each single one escapes the discernment of the sense.

Art. 5. That of *Aristotle* and the *Stoicks*, refuted: and *Chrysippus* subterfuge, convicted of 3 Absurdities

These two so highly repugnant Opinions being thus rightly stated, it follows, that we uprightly perpend the Verisimility of each; that so we may confer our Assent upon the more ponderous. If we look no further than the *Commmon Notion*, or what every man understands by the Terme, *Mistion*; it is most evident, that the things commixed ought to *Remain* in the *Mistum*; for if they do not remain, but Perish, both according to substance and Qualities, as *Aristotle* and the *Stoicks* hold; then is it no Mistion but a *Destruction*: and since the propriety of this Notion cannot be solved by any other reason, but that of the *Atomists*, that the particles of things are in commistion onely apposed each to other, without amission of their proper natures; what Consequence can be more naturall and clear than this, that that their opinion is most worthy our Assent and Assertion? (2) Though *Chrysippus* attempts to conserve the integrity of this Common Notion, by a subtlety, saying; That the most minute particles of things mixed, do so remain entire both as to substance and Qualities, as that they reciprocally penetrate each other, and become mutually Coextended; and that thence it comes to pass, that in the whole *Mistum* there is none the smallest particle, which is not mixed, or which doth not partake aswell of the substance, as Qualities of every ingredient therein: yet doth He not onely fall short of his designe, but also further entangle himself, and subvert other more manifest Notions. For, from that his Position it necessary follows. (1) That two Bodies are at once in one and the same place, both mutually penetrating each others dimensions, or without reciprocall expulsion. (2) That a pint of Water, and a pint of Wine commixed, must not fill a quart, but that both are no greater than one, i. e. be both contained in a pint together: forasmuch as it supposeth, that the particles of one have no other Ubi, but what is possest by the particles of the other. (3) That a very small Body may be Coextensive, or Coæquate to a very great one; as that a spoonfull of Water may be Coæquate to a But of Wine: since it supposeth, that, both being commix't, there is no part of space in the vessel including them, which doth not contain somewhat of the Water as well

as of the Wine. Now, all these things being manifestly Repugnant, and yet naturally Consequent upon *Chrysippus* Position: it is no less repugnant, that the particles of things commixt should remain, by mutuall Penetration, and Coextension.

Art. 6. *Aristotles* two-fold Evasion of the Incongruities attending the position of the *Remanence of things commixed, notwithstanding their supposed reciprocal Transubstantiation:* found likewise meerly *Sophisticall.*

(3) Nor, indeed, hath *Aristotle* Himself been more happy than *Chrysippus*, in his invention of a way, to remove or palliate the gross repugnancy of his opinion, to the proper importance of the term, Commistion; as may easily be evinced by a short adduction of it to the test of reason. That He might defend his Doctrine of the Remanence of things commixed, notwithstanding their reciprocall Transubstantiation; and at the same time avoid those sundry manifest Ἀσύστατα, or Incongruities, to which that doctrine is subject: He excogitated *Two sophisticall* subterfuges. The one, that when two divers things are commixed, in very unequall proportions, so as the one is very much prævalent o're the other (as when one single drop of Wine is instilled into ten thousand Gallons of water) in that case there is no Mistion, in strick acceptation; but an absolute Exsolution and Transmutation of the species of the weaker into that of the stronger, (of the species of the Wine, into that of the Water.) The Other, that when the things commixed are so exactly equall in quantity or Virtues, as that one is not the least prævalent over the other; or when the one prævails upon the other but little: in both these cases, though each put on the nature of the other, by reciprocall transmutation, or that which is a little inferior be altered from its own nature into that of the Superior; yet is not that Transmutation of both, a Generation of either, or the transmutation of the one, a Generation of the other, but onely of some *Third* thing, which is *middle* betwixt, and *common* to both.

But, there is neither of these, which may not be called a *snare*, more justly than a subterfuge. For, as to the *First*; were *He* living, and in the Schools, we should onely demand of him, if after the instillation of one single drop of Wine into 10000 Gallons of Water, a second drop should be superinfused, and after that a third, a fourth, and so more and more successively, till the mass of Water were augmented to ten, a hundred, a thousandfold: *of what Nature would the whole mixture of Wine and Water be? He*, doubtless, would *Answer* Us, that the whole would still be Water, though to one measure of Water 10000 measures of Wine were superaffused drop after drop; since, according to His own theory, it allwayes must remain meer and simple Water (otherwise the first drop of Wine could not be transpecificated, or be converted into the nature of the Water) into which even the very last drop of Wine was infused: or else He must teach us when, i. e. from what particular drop of Wine instilled, the whole Aggregate or Mass of both liquors began to put off the nature of Water, and on that of Wine. And, who is so dull either by nature, or præjudice, as not to apprehend, that the Reason is the same for one, as for the other; for ten thousand thousand Gallons, as for one single Drop of Wine? Now this being *Absurd*, as far beyond palliation, as pardon; is it not much better for Us to say, that if one *drop of* Wine be infused into so large a quantity of Water, it is divided into very exile particles, each whereof doth still

ſtill retain the nature of Wine, but ſo commixed and adhæring to the incommenſurably more denſe and numerous particles of the Water; as that they ſeem to vaniſh, though really they ſtill ſubſiſt the very ſame, as before commiſtion? That Two drops being infuſed into the ſame Water, the particles therof becoming doubly more numerous, would be contingent and cohærent to more particles of the Water? That, if ten, a hundred, a thouſand, ten thouſand, a hundred thouſand; *&c.* Drops of Wine be ſucceſſively ſuperaffuſed into the ſame Water; the particles of the Wine would at length amount not only to an equall, but a greater number than thoſe of the Water: and conſequently ſo prævail over them, as to change their Virtue, and ſubdue them into the Apparence of Wine?

And as to the *Other*; we might very lawfully Except againſt it; as altogether *Unintelligible* (for, who can underſtand, How the Inferior Miſtile can be tranſmuted into the Nature of the ſuperior, and yet not be the very ſame thing with it?) but, leaſt we appear all ſeverity, we ſhall wave that cavill, and inſiſt onely upon the moſt important part of the Aſſertion. *Ariſtotle* ſaith, *That from the Commiſtion of two divers things, a certain Third thing is Generated, or Produced, which is of a Nature Median betwixt, and Common to Both thoſe things commixed.* Now, Whether is it His meaning, that the Reſulting middle and Common thing doth participate of the Extremes of Each miſtile: or, that it ariſeth from the Deſtruction of both Miſtiles? For the Text will endure no third interpretation. If the *Latter*; then do not either of the things mixed Remain, and ſo there can be no Miſtion: expreſly contrary to His own Aſſumption, and the tenour of that Common Notion, for the præſervation whereof He excogitated and deſigned this Subterfuge. If the *Former*, as ſeems moſt genuinely inferrible from the Adjectives, *Medium* and *Commune*; then our Enquiry is, How, and in what reſpect, that Middle and Common thing comes to be participant of the Extremes of each Miſtile? In the Wine (that we may retain his own Inſtance) there was Matter, there was Forme, there were Qualities; and likewiſe in the Water: ſhall we therefore conceive, that the Middle and Common thing produced, is participant of all, i. e. Matter, Forme, and Qualities of Both the Miſtiles; or onely of thoſe of one of them?

(1) For the *Matter*; He cannot deny, that the Miſtum containes the whole Matter of Both: becauſe neither the Matter of the one, nor of the other can be deſtroyed. And ſince the Matter of each hath Parts, the ſmalleſt of which is Extenſe or Quantitative, and ſo muſt poſſeſs a proportionate part of ſpace in the Continent; therefore we demand, whether are the Parts of the Matter of the Wine exiſtent in the very ſame places, with the Parts of the matter of Water; or in diſtinct places by themſelves? If He ſhould ſay, as the ſuppoſition implies, that the parts of Both do exiſt in one and the ſame place; He would ruine himſelf upon that Impoſſibility of the Coexiſtence of Two Bodies in one place: and if that they are in diſtinct places; then muſt it follow, that they onely touch each other ſuperficially, and ſo are not mixed by mutual Penetration and Coextenſion (as He affirmed) but by meer *Appoſition*, or *Compoſition.* (2) As to the *Forms*; *Ariſtotle* cannot but admit, that the

the Forms of both Wine and Water do ſurvive their Commiſtion, and exiſt in the Miſtum; or Middle and Common thing reſulting from them; becauſe, otherwiſe, there would be a plain Corruption, not a ſimple Alteration of the things mixed, and conſequently Miſtion ought to be defined rather *Miſtilium Corruptorum*, than *Alteratorum Unio:* Beſides, if the Formes periſh, the Emergent Form muſt be abſolutely *New*, and ſo not participant of the Form of each Miſtile. But; if He reply, that Both Forms are United and coexiſtent in the whole matter of the Miſtum; then muſt every the ſmalleſt particle of the matter of each have both the Form proper to it ſelf, and the Form of the other alſo, and ſo the whoſe matter muſt have two whole diſtinct Forms at once: which is an Abſurdity infinitely below the conceſſion of *Ariſtotles* ſubtility, and whether or no his Sectators will defend it, we leave to themſelves. To elude this Dilemma, He, indeed, hath determined, that the Form of the Miſtum is one only, and that neither of the Præexiſtent Forms, in Act, but both in *Power*. But, alas! this is a poor ſhift for ſo great a Philoſopher; for if the præexiſtent Forms of both Miſtiles be not Actually in the Miſtum, then are not the Miſtiles onely Altered, but wholly *Corrupted*: nor can it enter into the thoughts of any ſober man, How the Reſulting Form ſhould contain the Præexiſtent ones, in *Power*. For, if the Reſulting Form is capable of being changed again into the præexiſtent ones, from which it did reſult; as when Wine and Water commixed, are again ſeparated: that argues of neceſſity, that the Forme of the Miſtum is not a New Forme (as He aſſumes) but one Compoſed of the two præexiſtent ones commixed.

(3) And laſtly, as for the *Qualities*; neither ought *Ariſtotle* to deny the *Remanence* of them: for, ſince in them conſiſteth the chief Capacity or Power of recovering the laſt Forms; if they periſh, how can they be inſervient to the recovery of the Forms? Neceſſary it is, therefore, that the Qualities of things commix't be onely interchangably *Refracted*, not Aboliſhed. And thus have we demonſtrated, that *Ariſtotle*, aſwell as the *Stoicks*, engulfed himſelf in an Ocean of bottomleſs *Difficuties*, and irreconcilable *Incongruities*; while He ſought to propugne that unreaſonable Opinion, of the Mutuall *Confuſion*, and *Tranſmutation* of the things commixed in Generation. For a Collateral *Remark*, be pleaſed to reflect upon this great Example, when you would enforce, *How heavy a burthen lye's upon thoſe ſhoulders, which take upon them to ſupport an Error: and how weak the Armes of the moſt Giant wits are found when they ſtrive to bear up againſt the ſtream of Truth.*

Art. 7. That the *Forms* of things, ariſing in Generation, are no *New ſubſtances*, nor diſtinct from their matter: contrary to the *Ariſtoteleans*.

Having detected the ſundry Difficulties, that wait upon the Doctrine of *Ariſtotle*, touching the *Origination*, or *Emergency* of a *Form*, in a thing Generated from divers things commix't; let us proceed to Another Article of the ſame Chapter and enquire whether there be not alſo a very remarkable Difficulty inſeparable from his Doctrine of the *Eſſence* of that Forme; that ſo at length we may the better determine, *Whether the Forme of a thing Generated from Elements, or*

or other more compound Bodies commix't, be a ſubſtance (as *Ariſtotle contends*) or *onely ſome certain Quality, or Accident* (as *Democritus* and *Epicurus* aſſert.) But, firſt, we are to advertize, that from this Diſcourſe of ours, againſt the ſubſtantiality of Forms Generated, we exempt the *Rationall Soul of Man*; for, that being an Eſſence ſeparable from the Body, and ſubſiſting entire and complete after ſeparation (as we intend, if God ſhall be pleaſed to grant us health, and the world vacation from publique cares, to demonſtrate at large, in a ſingular Treatiſe) may therefore be moſt juſtly termed a ſubſtance, or Form ſubſtantiall: as intending onely to examine the reaſonableneſs of that opinion, by the Schools imputed to their Maſter *Ariſtotle*; that *the Forms of things are ſubſtantiall, and wholly diſtinct from Matter.* The Quæſtion (and indeed a very Great one) is, *Wherein that ſubſtance, or Form*, which *Ariſtotle* affirm's to ariſe, *de novo, in Generation, lay hid before Generation?* His *ſectators* unanimouſly tell us, that it was contained in the Matter, not in *Act*, but onely in *Power*, or *Capacity*: and we demand again, if it were not Actually contained in the Matter, how could it be Actually educed from thence? They reply, that it is educed out of the Matter onely by the Power of the Agent. But, this is a ſhamefull Deſertion of the Quæſtion, which is not about the Power of the Agent; but, How the Form of a thing, which themſelves aſſume to be a ſubſtance, i. e. a reall and ſelf-ſubſiſting Entity, and ſo clearly Diſtinct from the Matter of the Miſtum, can yet be Educed out of that very Matter? When they ſay, that the Form is concealed in the Power of the Matter; if they would but permit us to underſtand the Form to be a certain portion of the Matter, and as it were the Flower, or purer part thereof, which ſhould afterward, in Generation, be attenuated, refined, ſequeſtred from the groſſer maſs; and then be again conjoyned to the ſame, and as it were Animate it: then, indeed, might the Eduction of a Form, as a reall and ſubſtantiall Being, be eaſily conceived, and aſſented to. But, this they expreſly prohibite, leſt they ſhould incur a double Contradiction: the one, in conceding the Matter to be Corruptible; the other, in allowing the Form to be indiſtinct from Matter. Foraſmuch, therefore, as they proteſt againſt that Interpretation of the Text; and yet are peremptory, that the very ſubſtance of the Form educed, was before eduction potentially comprehended in the very ſubſtance of the Matter: they give us the trouble of ſtill preſſing them to explain How, or after what manner, the ſubſtance of the Form was Potentially contained in that of the Matter? And here they fly to their accuſtom'd refuge, an obſcure Diſtinction, ſaying; that the Power of the Matter, in reſpect to the Form, is Twofold: (1) *Eductive*, foraſmuch as the Form may be, by virtue of the Agent, educed out of it; (2) *Receptive*, foraſmuch as it receives that ſame Form educed. And ſo they conclude, that the Matter doth contain the Form in both theſe Powers, or double Capacity. But, this will not blunt the edge of Curioſity. For, as to the Firſt, *viz.* the *Eductive* Power; 'tis manifeſt, that to contain a thing by an Eductive Power, imports no more, nor leſs than this, to have Actually in it ſelf that, which is capable of eduction from

from it. Thus a Purſe, wherein ten pieces of money are actually contained, may well be ſaid to contain them by an Eductive power; becauſe He that hath the purſe, may at his pleaſure Educe them from thence: but, if the Purſe did not actually contain them, He that wanted money, might ſtarve before He could prove, that they were contained therein by an Eductive power.

And therefore we may ſet up our reſt in this Concluſion; that as a piece of Gold cannot be educed out of an Empty Purſe: ſo doth not Αμορφος, or Exforme Matter(ſo themſelves determine it to be) contain a Form, by an Eductive Power.

As to the Other member of the Diſtinction, the *Receptive* Power; tis alſo manifeſt, that to contain a thing by a Receptive Power, is no other than to be in a condition of Receiving it: but, this Capability, or Power Receptive comes much ſhort of being ſufficient, that any thing ſhould be actually educed from that, which hath onely ſuch a power of entertaining it; ſince otherwiſe the prodigall need not fear the exhauſtion of all the money in his purſe, becauſe it is capable of more, when that's gone. Which being moſt groſly Abſur'd; it cannot be leſs Abſurd to conceive, that the Form of a thing may be educed from the matter thereof, becauſe it is contained therein by a Receptive Power. Indeed, if they would allow the Form to be, not a ſubſtance, but a certain Quality, ſpecies, or modification of a ſubſtance or Matter; then might we underſtand how it might be contained in the Power of the Matter; becauſe the ſenſe would be no more than this, that the Matter is capable of being ſo changed and diſpoſed, as to be put into ſuch a Mode, or Form: by the ſame reaſon, as the ſpecies, or Image of Mercury may be ſaid to be contained in the power of a piece of wood, or be educed out of it; inſomuch as the wood is capable of being formed into the ſtatue of Mercury, by the hands of the ſtatuary.

But, while they make the ſpecies or Image of Mercury, to be a New ſubſtance, abſolutely diſtinct from the wood, which is the ſubſtance, or Matter of that Image; and in Generall diſcriminate the Figure, or Forme of a thing, from the ſubſtance of the thing it ſelf: we are to be excuſed, if we do not at all underſtand them, in more than this, that they endeavour to aſſert what themſelves do not, nor cannot underſtand.

Art. 8. That the *Form* of a thing, is only a certain *Quality*, or *determinate Modification of its Matter.*

But, as for the *other* Philoſophers, formerly nominated; if you pleaſe to convert your attention to the ſummary of their theory concerning the ſame Argument, we doubt not but in the concluſion you will concur with us in this judgement, that They ſpeak (at leaſt) both much more intelligibly and ſatisfactorily. They deny not, that Generation is indeed, determined to a ſubſtance, becauſe the the thing produced or generated, is a ſubſtance. Nor that in generation there alwayes ariſeth a Forme, by which the thing generated is ſpecified; becauſe Generation ſuppoſeth ſpecification, and ſpecification imports a Forme. Nor, again, that that Form is really a ſubſtance, *i. e.* a certain moſt

moſt tenuious, moſt ſpiritual, and ſo moſt active part of the Body, ſuch as we have often hinted the ſoul of a Plant or Brute Animal to be. But the points which they declare againſt, as manifeſtly unreaſonable, are theſe Two: (1) That ſuch a Forme is a New ſubſtance, or formerly not Exiſtent; becauſe it is unavoidably neceſſary, that that moſt tenuious, moſt ſpiritual, and moſt active portion of the matter ſhould be ſomewhere præexiſtent, before it was copulated to the groſſer and leſs active part of the maſs, and affected it with ſuch a particular mode, as ſpecifies the miſtum: (2) That that which is properly called the Forme of a thing, is ought elſe but a certain Quality, or determinate Manner of the ſubſtances exiſting, or ſpecial Modification of the matter thereof. For, it being unanimouſly decreed by them All, that every thing is generated from an Aggeries of Matter, or Material Principles, coaleſcing in a certain Order and Poſition: they therefore determine, that the thing generated, or Concreted, is nothing but the very material Principles themſelves, as convened and coaleſced in this or that determinate Order and Poſition, and ſo exhibited to the cognizance of our ſenſes, under this or that determinate Forme, Species, or Quality. And leſt we ſhould delude our ſelves, by a groſs apprehenſion, that the tenuious and more agile part of the body is only confuſedly blended together with the groſs and leſs agile part; *Empedocles and Anaxagoras* tell us præciſely, that the Forme of the whole, or Quality by which the Body is made ſuch as it is, doth yet reſult from as well the order and ſituation of the tenuious parts among themſelves, and of the groſſer among themſelves, as of the tenuious and groſſer conjunctively, or one among another. And this they illuſtrate by the ſimilitude of an Houſe. For, as an Houſe is nothing but Timber, Stones, Morter, and other materials, according to ſuch or ſuch a reaſon and order diſpoſed and contexed together, and exhibiting this or that Forme; and as there is nothing in it, which before the ſtructure thereof was not found in the wood, quarry, river, and other places, and which after its demolition (whereby its Forme periſheth) doth not ſtill exiſt in ſome place or other: ſo is a Horſe (for example) nothing elſe but thoſe material Principles, or exile Bodies, of which after a certain manner connected among themſelves it is compoſed, both with this determinate Conformation of Members, and this interior Faculty of Vegetation, and in a word, with this particular Forme, Quality, Species, or Condition, which denominates it a Horſe; when yet the Principles of which both its Groſſer members are coadunated, and its tenuious and ſpiritual ſubſtance, the ſoul, is contexed, were formerly exiſtent in his progenitors, in graſs, in Water, Aer, and other Concretions; and the Form alſo, ſo ſoon as the Compoſitum is diſſolved, vaniſheth, as well the tenuious as groſſer particles returning again to aer, water, earth, or other Bodies, as they were before their Concretion, or Determination to that particular ſpecies of things, by Generation.

Art. 9. An abſtract of the theory of the *Atomiſts*, touching the ſame.

But, *Democritus*, *Epicurus*, and *Leucippus* are ſomewhat more full and perſpicuous in their Solution of this Problem, declaring (1) That, when a Thing is Generated, multitudes of Atoms are congregated, commixed, compoſed, diſpoſed, & complicated after ſuch a determinate manner, as that from thence doth neceſſarily reſult a body of ſuch a particular ſpecies, apparence, and conſequently of ſuch a reſpective denomination. (2) That in ſuch a Body there is no ſubſtance, which was not præexiſtent, it being impoſſible that New Atoms (which only conſtitute Corporeal ſubſtance) ſhould be created: but only that ſuch a certain Diſpoſition and Configuration of the Atoms, eternally præexiſtent, is made, from which ſuch a Form ariſeth, which

 is

is nothing really distinct from, but is the very Atoms themselves, as they are thus, and no otherwise ordered and composed. (3) That the Forme of a thing, considered abstractly or by it self, is therefore onely a meer Quality, Accident, or Event, of which the Atoms, which compose that Body or substance, are naturally capable, when thus consociated and mutually related: whether we understand it to be the Forme of the whole Compositum, or of that most subtile and active part of the substance commonly called the Soul, or specifical Forme (V. G. of an Horse) the same being (not a New, or freshly created substance, as *Aristotle*, and the *Schools* upon his Authority conceive, but) only a certain Contexture of the most subtile and moveable Atoms in the composition. (4) That out of the infinite stock of the Universal and First Matter, unceßantly moving in the infinite space, when such Consimular Atoms meet together, as are reciprocally proportionate or respondent, and mutually implicate each other by their small Hooks and Fastnings; then are generated certain very small Bodies, or *masses*, such as being much below the discernment of the sense, may be accounted *Semina Rerum*, the seeds of things: differing from the *Homœomerical Principles* of *Anaxagoras* in this, that though very hardly, yet at last they may be dissolved, and reduced to the single Atoms, of which at first they were composed; whereas the *Homœomera* of *Anaxagoras* are *Irresoluble*, and *First Principles*. (5) That these *Moleculæ*, First Masses, or smallest Concretions of Atoms, are the Proxime and Immediate Principles of Fire, Water, Aer, and of other things more simple, such as the Chymists conceive their Three Catholique Principles, Sal, Sulphur, and Mercury to be: from which afterward congregated and commixt into greater masses, arise various kinds of Bodies, respectively to the various manners of their commistion, disposition, and concretion; as Animals, Vegetables, Minerals. (6) That from the Dissolution of Bodies composed of divers sorts of such First Masses of Atoms, such as Animals, Plants, Minerals, and each of their several species; divers Bodies of more simple Compositions may be Generated, according as the small masses or Complications of Atoms, separated, by dissolution, from them, shall be more or less Consimilar, and convene again in this or that order and position, or particular species; as when from wood dissolved by Fire, are generated Fire, Smoke, Flame, Soot, and Ashes. And this is the Summary of the Atomists Doctrine concerning the essence of Forms: which that we may conveniently illustrate, let us a while insist upon that most opportune instance of the Generation of those divers things, *Fire*, *Flame*, *Smoke* *Soot*, *Ashes*, and *Salt*, from the Dissolution of *Wood*.

Art. 10 An illustration thereof, by a prægnant and opportune *Instance*. viz. the Generation of *Fire*, *Flame*, *Fume*, *Soot*, *Ashes* and *Salt*, from *Wood* dissolved by Fire.

Let us conceive (1) That Wood is a Compound Body, made up of various Moleculæ, or small masses of Atoms: (2) That those small masses of Atoms are such, as that being congregated, commixt, and according to such a determinate manner disposed, they must in the whole composition, retain the species or Forme of Wood; but being dissociated, separated, and after another manner again connexed and disposed, they must exhibite other less compound Forms, or species of Bodies: (3) That in the Concretion there are existent multitudes of spherical, most exile, and most agile Atoms, such as, when they are expeded from the fetters of the grosser mass, and flye away together in great numbers, and consociated, are comparated to make and exhibite the species of Fire: (4) That of these Igneous particles is generated *Flame*. Whose *Clarity* & *Splendor* ariseth from the Abjection of other dissimilar and impure parts, formerly commixt with the Igneous particles. Whose tendency *Upwards*, and succeeding *Disapparence* arise both from the force and pernicity of the Igneous particles in their exsiliti-

on,

on, and the preſſure or urgency of the ambient Aer. Whoſe gradual *Attenuation*, and *conicall Figure* ariſe from hence, that the Igneous particles, in reſpect of their roundneſs, exility, and ſuperlative mobility, evolving and expeding themſelves from the Concretion the ſooneſt of all others contained therein, and in ſwarms diffuſing themſelves through the environing aer, on all ſides, do create a Light, which is by degrees ſo exhauſted, in regard of the ſpeedy avolition of the igneous Atoms compoſing it, that it dwindles or conſumes away to a cone or ſharp point, which is alſo much more rare then the baſis, where the igneous particles are moſt denſe and agminous. Whoſe *Dilatation* from its baſe to ſome degrees, and *Tremulation* or *Vndulation* ariſe from the copious, but indirect emption of the igneous particles, diſengaging themſelves from the groſſer parts of the mixture. Whoſe *Obnubilation* by ſome ſmoke commixt with it, is cauſed by the many Fuliginous particles, that the Igneous ones carry off with them, as they flye away. Whoſe faculty of *Pungency*, *Penetration*, and *Diſſolution* of moſt bodies objected, conſiſteth in the tranſcendent ſubtility of the Igneous particles, and in the pernicity of their motion, as we have largely declared in our præcedent Diſcourſe of the Nature of Heat. (5) That the *Fume*, or ſmoke iſſuing from wood in combuſtion, together with Flame, is much more ſimple than the wood it ſelf, but yet compounded of divers particles, ſome whereof are Watery, others Earthy, others Salt, others Fuliginous, as appears by the adhærence of the ſoot to the Chimny, by the præcipation of the earthy fæces of ſoot to the bottom of a veſſel of Water, and the extraction of Salt from thence by a diſſolution of ſoot in warm water, and the Denigration of things thereby. (6) And laſtly, that what we have conc.ived of Flame and Smoke, may be equally reaſonable, if applied alſo to the remaining *Aſhes* of wood burned, they being likewiſe compoſed of various particles or ſmall maſſes both of *Salt* and *Earth*; and the particles of Earth being again compoſed of Mud and Sand, or ſuch as that of which Glaſs is made. And when we have perpended the veriſimility of theſe Conceptions, we ſhall be fully convinced; that Wood is a thing compoſed of divers ſorts of ſmall bodies, or minute maſſes of Atoms; and that the Form thereof doth conſiſt in the Congeries, Concretion, complexion, and determinate Diſpoſition of them all; as alſo that the Fire, or Flame iſſuing from it in combuſtion, is a thing likewiſe conſiſting of various ſorts of particles contained in the Wood, and which being ſeparated, and again conſociated (according to the Conſimilarity or likeneſs of their natures) and concreted among themſelves, obtain another Diſpoſition, and Forme, and ſo exhibite the ſpecies of a New body.

Sect. II.

Art. 1. That in Corruption, no *substance* perisheth; but only that determinate *Modification* of substance, or Matter, which specified the thing.

FRom Generation (as in the Method of Nature, so in our disquisitions concerning Her) we pass to CORRUPTION; which is no more but the Dissolution of the Forme, i. e. the determinate Modification of the matter of a thing, so that it is thereby totally devested of the right of its former Denomenation. For, since it is most certain, that in Generation, there doth arise no such New *substantial* Forme, as *Aristotle* dreamt of, and most men have ever since disquieted their heads withal: it can be no less certain, that neither in *Corruption* can any such Form, as ever was *substantial*, perish or be annihilated. Which verily that we may most commodiously enforce, resuming our late *Instance* of the Generation of Fire, Flame Smok, &c. from the combustion of wood, we shall to our præcedent remarks there thereupon, superad this observation; that when wood perisheth by Fire, and so is resolved into divers other Bodies, it is not resolved into any other, but those very same things, which were really præexistent and contained therein; and consequently, that nothing thereof perisheth, but only that determinate Connexion and situation of its parts, or that special manner of their existence, (you may call it Forme, Quality, Species, Accident, or Event) in respect whereof it was wood, and was so denominated. A strange Assertion you'l say, that there is really existent in wood, Fire, that there is Flame, that there is Salt, that there are all those divers things into which it is resoluble by corruption. And yet the Truth much transcends the strangeness of it; the difficulty, at which you are startled, consisting only in Name, not in the Thing it self. For, if by Fire you understand burning Coales or Flame actually ardent and lucent; and if by Salt you conceive a Body sapid, really and sensibly corrading the tongue: then, indeed, we shall confess that there is no such Fire, nor Flame, no such Salt existing actually in wood: But, if you by the names of Fire, and Salt, understand (as the tenour of our Dissectation, both directeth and obligeth you to understand) the seeds, or small masses, or first Concretions of Fire and Salt, such which are so exile, as that each of them singly accepted is very much beneath the perception and discernment of the most acute of senses; but yet when multitudes of them are sequestred from the whole mass, and are again congregated and freshly complicated together, the seeds of Fire by themselves, those of Salt by themselves; then do these actually burn and shine, and those actually make a Sapour, sharply affecting and corrading the tongue: we see no reason, why you should wonder at our tenent, that both Fire and Salt, *viz.* that very Fire which burns and shines in the wood, that very Salt which may be extracted from the Ashes thereof, were præexistent in the wood. Certainly, you cannot but admit as highly consentaneous to reason; that in a vapour to what rate soever attenuated, there are contained the seeds of Water, or the first concretions of Aqueous Atoms; which though singly existent they are wholly imperceptible, yet nevertheless are they really particles of water: for as much as they want only the convention and coalition of many of them together, to the discovery

very of their nature in ſenſible maſſes; for of many of them condenſed are made very ſmall drops of water, of thoſe drops aſſembled together ariſe greater drops, of thoſe rain is generated from that rain ariſe whole ſtreams, and many of thoſe ſtreams meeting together ſwell into great and impetuous torrents. And if this be ſo eaſily, why ſhould that be ſo hardly admittible?

Art. 2. Enforcement of the ſame Theſis, by an illuſtrius *Example.*

But to deſert this Example, and addreſs to another ſo competent and illuſtrious, that it takes off all obſcurity as well as difficulty from our conception; it is well known, that ſilver is capable of ſuch exact permiſtion with Gold, as that though there be but one ſingle ounce of Silver admixt by confuſion to 1000 ounces of Gold: yet in the whole maſs there ſhall be no ſenſible part, wherein ſomewhat of that ſmall proportion of ſilver is not contained. Now, you cannot expect that each ſingle molecula, or ſeed of ſilver ſhould appear to the ſenſe, ſo as to diſtinguiſh it ſelf, by its proper colour from the ſmall maſſes of Gold: becauſe each molecula of ſilver is ſurrounded with, and immerſed among 1000 particles or ſmall maſſes of Gold. Nor can you believe, that the ſilver is wholly unſilvered, or Changed into Gold; as *Ariſtotle* affirmed, that a drop of Wine, infuſed into a great quantity of Water, is changed into Water: becauſe the skilful Metalliſt will ſoon contradict you in that, by an ocular demonſtration. For, by Aqua Fortis poured upon the whole maſs, He will ſo ſeparate the ſilver from that ſo exceſſive proportion of Gold, as that there ſhall not be left inhærent therein ſo much as one the ſmalleſt particle thereof; and in the ſuperfice you may plainly diſcern multitudes of very ſmall holes, (like punctures in wax, made by the point of the ſmalleſt needle) in which the moleculæ or ſmall maſſes of the ſilver were reſident, before its ſequeſtration from Gold. Why therefore, according to the ſame reaſon, ſhould it not be equally probable, that the ſeeds, or particles of Fire are ſo ſcatteringly diffuſed through the ſubſtance of wood, as that being ſurrounded and overwhelmed with myriads of particles of other ſorrts, they cannot therefore put on the apparence proper to their nature, and diſcover themſelves to be what really they are, until being by the force of the external fire invading and diſſolving the compage of the wood, ſet at liberty, and diſengaged from their former oppreſſion, they iſſue forth in ſwarms, and by their coemergency and conſimilarity in bulk figure and motion being again congregated, they diſplay themſelves to the ſenſe in the illuſtrious Forme of Fire and Flame, and proportionately diminiſh the quantity of the wood; which thereupon is firſt reduced to Coals, and afterward, the ſeparation and avolation of more and more particles ſucceſſively being continued, to Aſhes, which containing no more igneous particles, can maintain the combuſtion no longer.

Art. 3. An *Experiment* demonſtrating that the *Salt* of *Aſhes* was præexiſtent in Wood; and not produced, but only *educed* by Fire.

The like may be ſaid alſo of the Salt, diffuſedly concealed in Wood. For, inſomuch as each ſingle particle of Salt ambuſcadoed therein, is blended among, and as it were immured by myriads of other particles: it is impoſſible they ſhould exhibite themſelves in their genuine Forme, while they remain in that ſtate of ſeparation or ſingular exiſtence; which they muſt do, till the compage of the whole maſs or Concretion be diſſolved. And would you be, beyond all pretext of doubt, convinced, that they yet retain their proper nature, amidſt ſuch multitudes of other particles; be pleaſed only to make this eaſie Experiment. Take two pieces of the ſame Wood of equal weight, and ſteep one in water, for two or three days, and keep the

the other from all moyſture; then by fire reduce each of them apart to Aſhes, and by Water affuſed thereunto, and boyled to a lee, extract the Salt from the Aſhes of each: this done, you ſhall find the Aſhes of the drie piece to have yeelded a quantity of Salt proportionate to its bulk, but thoſe of the wet one very little, or none at all. And the Reaſon is only this, that the water in which the one piece was macerated, hath exhauſted moſt part, if not all of the Salt, that was contained therein. Now this Example we alledge to prævent your falling upon that vulgar conceit, that the Salt of Aſhes is produced only by the Exuſtion of the Wood: ſince, according to that ſuppoſition, the macerated piece of wood would yeeld as much of Salt, as the Drie. This conſidered, it remains a firm and illuſtrious truth, that all the particles of the Fire, Salt, Smoke, &c. educible from wood, were really præexiſtent therein, though ſo variouſly commixt one among another, as that notwithſtanding each of them conſtantly retained its proper nature entire, yet could they not diſcover themſelves in their own colours, proprieties, and ſpecies, till many of each ſort were diſ-engaged from the Concretion at once, and aſſembled together again.

Art. 4. The true ſenſe of three General *Axioms*, deduced from the precedent doctrine of the *Atomiſts*.

Now ſuch are the Advantages of this Theory above that of *Ariſtotle*, that beſides the full ſuffragation of it to the Common Notions of Generation and Corruption, of ſubſtance, Forme, &c. it aſſiſts us in the expoſition of Three General Axiomes, which though drawn into rules by *Ariſtotle* himſelf, are partly inconſiſtent with, partly unintelligible from his doctrine.

The Firſt is, *ſi aliquid corrumpitur ultimum abire in primam Materiam*, That when any thing is corrupted, it is at laſt reduced to the Firſt matter: which doth expreſly contradict His grand theſis, that the Forme of a thing is a ſubſtance, which begins to be in Generation, and ceaſeth to be, or is annihilated in Corruption; for, had He ſpoken conformably thereto, He muſt have ſaid, that when the Compoſitum is diſſolved by Corruption, it is partly reduced to matter, partly to Nothing. But, if the Form be not ſubſtantial, and that what is Corrupted, is compoſed of no other ſubſtantial parts, but thoſe which are material; as we have aſſumed: then, indeed, doth the Axiome hold good, and we may with good reaſon ſay, that when any thing is Corrupted, it is reduced to matter, or the material parts, of which it was compoſed, as wood diſſolved by fire, is reduced to Fire, Smoke, Soot, Aſhes, &c. of which it did conſiſt. And foraſmuch as by that Adverb, *Ultimum*, Finally, He gives us the occaſion of Enquiring, *An in Corruptione detur reſolutio aduſque materiam Primam?* Whether or no in Corruption there be a Reſolution even to the Firſt matter? we cannot but obſerve, that the manner of that ultimate reſolution may be much more eaſily comprehended, according to our aſſumption, than according to His own. Becauſe Our Firſt matter is Atoms, and the ſecond matter certain ſmall maſſes of Atoms, or the firſt Concretions, which we therefore, obſerving the phraſe of *Epicurus* and *Lucretius*, call *Semina Rerum*, the ſeeds of Things, ſuch as thoſe whereof Fire, ſilver, Gold, and the like Concretions are compoſed: and ſo, if the Reſolution proceed to extremity, i. e. to Atoms, or inexſoluble particles (as in ſome caſes it doth) then may it well be ſaid, that the reſolution is made to the Firſt Matter; but if it go no farther then thoſe ſmall maſſes of Atoms (as moſt commonly it doth not) then can we juſtly ſay no more, than that the reſolution is made only to the ſecond matter.

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The Second is, *Corruptionem Unius esse Generationem alterius*, that the Corruption of one thing is the Generation of another, which cannot consist with truth, if understood in any other sense but that of our supposition. For, since, Corruption is nothing else but a separation and exsolution of the parts, of which a thing was composed: we may conceive, how those parts so separated and exsolved, may be variously convened and commixt again afterward, as to constitute New Concretions, & put on other new Forms. Not that they were not formerly existent, as to all their substantial parts: but only that they were not formerly existent in a state of separation from others, nor coadunated again in the same compage, and after the same manner.

The Third, *Id quod semel Corruptum est, non posse idem numero naturæ viribus restitui*, that what is once Corrupted, cannot by Natures power be again restored numerically the same: which is to be understood in this sense. As a Watch, or other Artificial machine, composed of many several parts, may be taken in pieces, and easily recomposed again into the very same numerical Engine, both as to matter and Forme; the Artificer recollecting the divided parts thereof, and so disposing them, as that each possesseth the same place and position, as before its dissolution: so likewise might the same Natural Compositum, V. G. a piece of Wood, be, after the separation and exsolution of all its component parts, again recomposed numerically the very same, both as to matter and Forme, in case all those dissolved parts could be recollected, reunited, and each of them restored to its former place and position. But, though all the various parts thereof remain, yet are they so scattered abroad into so many and so various places, and commixt (perchance) with so many several things, that there is no Natural Power that can recollect and restore them to the same places and positions, which they held before their disunion and dissolution. And, therefore, if any man shall say, that such or such a thing, dissolved by Corruption, is capable of being restored again the same *in specie*; we ought to understand him no otherwise than thus: that some of the parts of that thing may so return, as that being conjoyned to others, not numerically the same, but like unto those, to which they were formerly conjoyned, they may make up a body exactly like the former, *in specie*, or of the same Denomination; as when the Carcase of an Horse is corrupted, some parts thereof are converted into Earth, some of that Earth is converted into Grass, some of that Grass eaten by another Horse, is again converted into Seed, whereof a third Horse is generated. And thus are we to conceive the endless Circulation of Forms.

Art. 5. The General Intestine *Causes* of Corruption, chiefly Two: (1) the *interception of Inanity among the solid particles of Bodies*; (2) *The essential Gravity and inseparable Mobility of Atoms.*

As for the Principal CAUSES of Corruption, (omitting the consideration of such as are External, or invading from without, in respect they are innumerable; and of that Internal one also, the intestine war of Elements in every Concretion, of which *Aristo le* hath such large discourses, and the Schools much larger) the theory of *Epicurus* instructs us, that they are only *Two*. The *First* and *Grand* one is the *Intermistion of Vacuity among the solid particles of bodies*; in respect whereof all Concretions are so much more easily Exsoluable, or subject to Corruption, by how much more of Vacuity they have intercepted among the solid particles, that compose them: according to that Distich of *Lucretius*.

Et

Et quam quæque magis cohibet res intus Inane,
Tum magis his rebus penitus tentata labascit.

The *other* is the *Ingenite Gravity*, or *natural and inamissible propensity of Atoms to Motion* which always inciteth them to intestine commotions and continual attempts of exsilition. So that where their Connexions and complications are but lax, and easily exsoluble, as in all Animals, all Plants, and some Metals, there do they sooner and more easily expede themselves, and so in short time totally dissolve the Concretions, which they composed. But, where they are bound to a more lasting peace, by more close compaction, and reciprocal complications, as in Gold and Adamants; there their inhærent propensity to motion is so suppreſt, as that they cannot disengage themselves each from other, without great difficulty, and after many hundred yeers continual attempts of evolution, convolution and exsilition. Which is the true Reason both why Gold is the least Corruptible of all things yet known; and why it is not wholly Incorruptible, but obnoxious to spontaneous Dissolution, though after perhaps a million of yeers, when after innumerable myriads of convolutions, the Atoms which compose it, have successively attained their liberty, and flye off one after another, till the whole of that so closely compacted substance be dissolved.

Art. 6. The *General Manners*, or Ways of Generation and Corruption.

From the Causes, our thoughts are now at length arrived at the MANNERS, or Ways of Generation and Corruption; and find them to be of Two sorts, *General* and *Special*. Concerning the *General*, we observe, that according to the doctrine of *Epicurus*, (whose great præhemnence in point of Verisimility and Concordance throughout, hath made us præfer it to that of *Aristotle*, which we have amply convicted of manifest Incomprehensibility, and self-contradiction) things are generated either immediately of Atoms themselves convened together and concreted, and resolved again immediately into Atoms; or immediately of præexistent Concretions, and resolved immediately into them again. Of the way how the *Former* is effected, we have said enough, in the second chapter of our Discourse against Atheism. As to the *Latter*, be pleased to understand, in a word, that all Generation is caused by either (1) *A simple Transposition of parts of the same numerical matter*, Or (2) *an Abjection of some parts of the old, or præexistent matter*, or (3) *An Accession of new parts*. For, howbeit all these three General ways of Generation are mostly so concurrent and commixt, as that one is hardly found without the association of the other two: yet when we consider each of them in special, and would determine which of them is prædominant over the others, in the generation of this, or that particular species of things: it will be necessary, that we allow this Discrimination. First, therefore, those things are said to be generated [κατὰ μετάθεσιν] by a meer *Transposition* of parts, which are observed to be spontaneous in their Production; as Frogs engendred only of mud or slime, Worms from putrid Chees, &c. because from the very self-same præexistent matter, only by a various transposition of its parts, & succeeding reduction of them to such, or such a determinate order & situation, something is generated, of a nature absolutely new or quite different from what that matter formerly had. And hither also are we to refer those *Transmutations of Elements*, of which *Aristotle* and the *Schools* have such frequent and high discourses: because, when Aer is conceived to be changed into Water, or Water

ter transformed into Aer; all the myſterie of thoſe reciprocal metamorphoſes amounts to no more, than a meer putting of the parts of the ſame common and indifferent matter into different modes, and the interception of more or leſs of Inanity among them, as we have frequently demonſtrated. Secondly, ſuch things are conceived to be generated [κατὰ πρόσθεσιν] by *Addition* or Acceſſion, which are not ſpontaneous in their original, but of ſeminal production, and ſpecificated by the univocal virtue of their ſeeds: becauſe in Propagation, rightly accepted, a very ſmall quantity of ſeed, pervading a greater maſs of matter, doth ferment, coagulate, and ſucceſſively appoſe more and more parts thereof to itſelf, and conform the ſame into the ſpecies of that thing, from which it was derived, and impræ̃gnated with the idea of the whole and every part thereof. And this Difference includes not only all *Augmentation*, which is a kind of Aggeneration, and conſiſteth only in the Appoſition of new matter or ſubſtance, and that in a greater proportion than what is decayed or exhauſted: but alſo every *Compoſition* whatever, ſuch as is the *Inſition* or *Inoculation* of Plants. Thirdly, ſuch things are ſaid to be generated [κατ' ἀφαίρεσιν] by *Detraction* which ariſe from the Diſſolution of others, and ſubſiſt only by Excretion or Separation; as Fire, Smoke, &c. are derived from the Diſſolution of wood, and other combuſtible ſubſtances, to which they were formerly commixt; and Wax from the ſeparation of Hony, together with which it was blended in the Combs. And, as for the Contrary, *Corruption*, 'tis eaſie to deduce it from the contrary ways of diſpoſing matter.

Art. 7. Inadvertency of *Ariſtotle* in making *Five* General Modes of Generation

And here again the incircumſpection of *Ariſtotle* manifeſtly diſcovers it ſelf; who multiplies the General ways of Generation, to a ſuperfluous number: expreſly teaching, that every ſimple Generation ariſeth from (1) either *Transfiguration*, as when a ſtatue is made of molten metal; or (2) *Addition*, as when Vegetables or Animals are Augmented; or (3) *Ablation*, as when a ſtatue is hewn out of Marble, all ſuch parts being cut off and abjected, as were ſuperfluous to the perfection of the Figure deſigned; or (4) *Compoſition*, as in the ſtructure of a houſe of various materials compoſed, according to the rules of Architecture; or (5) *Alteration*, when a thing is changed as to matter, as when Aſhes are produced out of wood combuſt. When notwithſtanding, had not his accuſtomed diligence been laid aſleep, or judgement perverted, he muſt ſoon have perceived, that his Transfiguration, Addition, and Ablation are really the very ſame with the Tranſpoſition, Adjection, and Detraction of our *Epicurus*; and that Compoſition is neceſſarily referrible to Addition, and Alteration to Tranſpoſition.

Art. 8. The *ſpecial* Manners of Generation, innumerable; and why.

Concerning the *Special* modes, or ways of Generation, we need advertiſe you of only two Conſiderables. (1) That each of the three General ways, newly mentioned, is ſo fruitful in poſſible variety, as that the ſpecial ſubordinate ones, whereof it is comprehenſive, are (if not infinite, yet) abſolutely innumerable, ineffable, incomprehenſible. For, if the Letters of our Alphabet, which are but 24 in number, may be ſo variouſly compoſed, as to make ſuch a vaſt diverſity of words, which cannot be enumerated by fewer then 39 cyphers, *viz.*

2952327990396041408476186096435200000000.

(*Tantum Elementa queunt, permutato ordine ſolo*)

What Arithmetician can compute the ſeveral ſpecial ways of compoſition, whereof that incomprehenſible variety of Figures which (as we have frequently aſſumed) Atoms may bear, is eaſily capable?

Art. 9. All ſorts of Atoms, not indifferently competent to the Conſtitution of all ſorts of thing.

(2) That, as the Image of Mercury cannot be carved out of every ſtone, or every piece of wood; nor words fit for reading, or pronunciation ariſe from every commiſtion of Letters: ſo, in Natural Concretions is it impoſſible, that all things ſhould be made of all ſorts of Atoms, or that all Atoms ſhould be equally accommodate to the conſtitution of every ſpecies of Concretions. For, though Atoms of the ſame figure and magnitude may, by their various tranſpoſition, adjection, ablation, compoſe things of various forms or natures: yet are they not all indifferently diſpoſed to the compoſition of all things, nor can they be connected after one and the ſame manner, in divers things. Becauſe, to the compoſition of every thing in ſpecie, is required ſuch a ſpecial diſpoſition in the Atoms, which compoſe it, as that they muſt appoſe to themſelves ſuch other Atoms, as are congruous and ſuitable to them, and as it were refuſe the ſociety and combination of others that are not. And hence is it, that in the Diſſolution of every Concretion, the conſimular or like Atoms always conſociate together, and expede themſelves from the Diſſimilar and incongruous.

CHAP.

CHAP. II.

OF MOTION.

SECT. I.

CERTAINLY, the Great *Galilæo* did moſt judiciouſly and like himſelf, to lay the foundation of his incomparable Enquiry into the moſt recondite myſteries of Nature, in the Conſideratin of the Nature of MOTION, and ſevere Examination (that we may not ſay, ſubverſion) of *Ariſtotles* Doctrine concerning it. Becauſe, Motion being the Heart, or rather the Vital Faculty of Nature, without which the Univerſe were yet but a meer Chaos; muſt alſo be the nobleſt part of *Phyſiology*: and conſequently, the ſpeculation thereof muſt be the moſt advantageous Introduction to the Anatomy of all other parts in the vaſt and ſymmetrical Body of this All, or Adſpectable World. Again, if Motion and Quiet be the principal modes of Bodies Exiſting, as *Des Cartes* (*in princip. philoſoph. part.* 2. *ſect.* 27.) ſeems ſtrongly to aſſert; if Generation, Corruption, Augmentation, Diminution, Alteration, be only certain ſpecies, or more properly the Effects of Motion, as our immediately præcedent Chapter cleerly imports; and that we can have no other Cognizance of the conditions or qualities of ſenſible objects, but what reſults from our perception of the Impulſes made upon the organs of our ſenſes, by their ſpecies thither tranſmitted: aſſuredly, the Phyſiologiſt is highly concerned to make the contemplation of *Motion*, its *Cauſes*, *Kinds*, and *Univerſal Laws*, the *Firſt* link in the chain of all his Natural Theorems. And, truly, this we our ſelves had not endeavoured, had not our firm reſolution to avoid that ungrateful prolixity, which muſt ariſe from the frequent Repetitions of the ſame Notions, in the ſolution of various natural Apparences; and our deſign of inſenſibly præparing the minde of our Reader, with the gradual inſinuation of all both Cauſes and Effects of ſpecial motions, as they ſtood in relation to this or that particular ſenſible object, and principally to Viſibles, and the Gravitation of Bodies: not only inclined, but

Art. 1. Why the Nature of *Motion*, which deſerved to have been the ſubject of the firſt ſpeculation, was reſerved to be the Argument of the *Laſt*, in this Phyſiology.

but by a neceſſity of Method almoſt conſtrained us, to make that the *Hem*, or Fringe, which otherwiſe ought to have been the *Firſt Thread* in this rawe and looſely contexed Web of our *Philoſophy*.

Nor, indeed, can we yet prævent all Repetitions; for, our præſent Theorem being *Phyſicomathematical*, and ſuch as muſt borrow ſome light, by way of Reflection, from ſundry obſervables, occaſionally diffuſed upon ſeveral of our Diſcourſes præcedent: we need not deſpair of a Diſpenſation for our Recognition of a few remarkable paſſages, directly relating thereunto, and eſpecially of theſe *Three Epicurean Poſtulates*, or Principles.

Art. 2. An *Epicurean* Principle, of fundamental concern to motion.

The FIRST; *that the Adam or Radical and Primary Cauſe of all motion competent to Concretions, is the inhærent Gravity of their Materials, Atoms: whether the Concretion be moved ſpontaneouſly, or violently, i.e. by it ſelf, or another.* The *Reaſon* of its ſpontaneous or ſelf-motion may be thus conceived. While Atoms are, by their own inamiſſible propenſity to motion, variouſly agitated and tumultuous in any Concretion; if thoſe which are more moveable and agile then the reſt, ſo conſpire together in the courſe of their tendency, as to diſcharge their united forces upon one and the ſame quarter of the body containing them, and ſo attempt to diſengage themſelves toward that region: then do they propel the whole body toward the ſame region, transferring the reſt of their leſs active aſſociates along with them. It being highly conſentaneous, that motion may be expreſſed firſt in the ſingular Atoms themſelves, then in the ſmalleſt maſſes, or inſenſible Combinations of Atoms; and ſucceſſively in greater and greater, till the ſenſible parts of bodies, and at length the whole bodies themſelves participate the motion, and undergo manifeſt agitation: as *Lucretius* (*in lib.* 2.) hath with lively Arguments aſſerted.

Art. 3. *Ariſtotles* Poſition, *that the firſt Principle of motion, is the very Forme of the thing moved*; abſolutely incomprehenſible: unleſs the Form of a thing be conceived to be a certain tenuious Contexture of moſt ſubtile and moſt active Atoms.

And this, certainly, hath far a ſtronger claim to our aſſent, than that fundamental Poſition of *Ariſtotle*; that *the Firſt Principle of motion in any thing, is the very Forme of the thing moved.* For, unleſs He ſhall give us leave, by the word Forme, to underſtand a certain tenuious Contexture of moſt ſubtile and moſt active Atoms, which being diffuſed through the body or maſs conſiſting of other leſs ſubtile, and in reſpect of their greater compaction together, or more cloſe reciprocal revinction, leſs active Atoms; doth, by the impreſſion of its force or Virtue motive, upon the whole, or any ſenſible part thereof, become the Principle of motion to the whole body: we ſay, unleſs he ſhall be pleaſed to allow us this interpretation, we ſhall take the liberty to affirm, that it is abſolutely incomprehenſible. For, that the Forme of a thing, accepted according to His notion of a Forme, ſhould be the Proto-cauſe or Principle of its motion; is unconceivable; ſince, according to the tenour of *Ariſtotles* doctrine, the Forme muſt be educed out of the Matter, or power of the Matter, that conſtituteth or amaſſeth that thing: and conſequently, the Forme muſt owe as well its very Entity or Being, as all its Attributes onely to the matter it ſelf; which yet He deſcribes to be ſomething (rather, nothing) meerly Paſſive, and devoid of all activity or Power whatever. How, therefore, can it appear other than a downright *Contradiction*, to any man, whoſe intellect is not eclipſed, by reaſon of ſome great diſorder of its proper Organ; that that Matter, which in it ſelf hath no Power or Faculty of Moving, ſhould nevertheleſs be able to impreſs a Faculty of motion, and potent Activity, upon the Form, ſuppoſed

Posed to be absolutely distinct from matter? Doubtless, the Forme doth not derive that Motive Virtue from the *Qualities* inhærent in the matter: forasmuch as those Qualities, as even the Aristoteleans themselves furiously contend, are but the meer Results of the Power of the matter. Nor from the *Efficient*; because They account the Efficient to be a Cause meerly External, and to transfuse nothing of it self into the thing Generated; but only to display its Efficiency, or (to speak in their own dialect) to execute its Causality upon the matter. Again, it being necessary, that all that Virtue of Moving, which is in the Efficient, should depend solely and wholly upon its Forme; and that Forme also ought, by equal reason, to be educed out of the matter: They lose themselves in a round of Petitions, and still reduce themselves to the same Difficulty, *How it is possible, that the matter should give that Faculty of Motion to the Forme, which it self never had.*

Art. 4. A second *Epicurean* Fundamental, concerning motion: and the state of the Difference betwixt *Epicurus*, *Aristotle*, and *Plato*, touching the same.

The SECOND; *that in General there is no other but Local motion.* Wherein that we may plainly and briefly instruct you, how far *Epicurus* differs from *Aristotle*, *Plato*, and some other Philosophers; give us leave to commemorate unto you.

(1) That *Aristotle* putting a difference betwixt [κίνησιν, καὶ μεταβολὴν] Motion and Mutation, is not sufficiently constant in his doctrine: sometimes making Mutation to be the Genus, and Motion onely a certain species thereof; and sometimes, by inversion of the tables, making Motion the Genus, and mutation a species thereof. For, (*in* 5. *physic. cap.* 2.) stating Mutation betwixt two Terms, *à quo, & ad quem*, the from whence and to what; He assigns unto 4 distinct Modes, or Manners; the first, *à subjecto in subjectum*; the second, *ex non subjecto in non subjectum*; the third, *ex non subjecto in subjectum*; the fourth *ex subjecto in non subjectum*: and thereupon infers, as of pure necessity, that since nothing can be changed according to the second mode, therefore must mutation according to the third, be Generation; according to the fourth, be Corruption; and according to the first, be Motion, which is always either from Quantity to Quantity, or from Quality to Quality, or from Place to Place. Whereas, in another place (*viz.* 3. *Physic.* 1.) He positively teacheth, that Motion is a certain Act, to which that passeth, which is in Power; and so makes the species thereof to be not only those motions, whose terms on either side are Positive, or (in his own phrase) Contrary, as are those which concern Quantity, Quality, Place: but those also, whose each term is Privative, as are those which concern substance. And hereupon He seems to have grounded that memorable Division of Motion (*lib. de prædicam. cap. de motu.*) into six species, *viz.* Generation, Corruption, Accretion, Diminution, Alteration, and Lation or Loco-motion: whereof the first two are according to substance; the second two, according to Quantity; the fifth, according to Quality; and the Last, according to Place.

(2) That *Plato* seems constantly to accept Mutation for the Genus, and motion for one species thereof: subdividing motion into two species, Lation and Alteration. Forasmuch as in one place (*viz. in Polit*) He terms the Conversions of the Cœlestial bodies, Mutations: and in another (*in Phæd.*) he takes Alteration for mutation; saying most eloquently in the person of *Socrates* (*in theat.*) *Illudne moveri appellas, dum quidpiam locum è loco*

è loco mutat, aut in eodem convertitur? Tho. *Equidem.* Socrat. *illa ergo una sit species motus. At, cum in eodem quidem perstat; sed senescit tamen, aut ex albo fit ingrum, ex molli durum, aut altereratione quapiam alterum evadit: an non videri alium motus speciem necesse est?* Tho. *mihi quidem videtur.* Socrat. *Necessarium id igitur; duas, inquam, esse motus species, Alterationem, & Lationem, Circulationemve?* &c.

(3) That most *other Philosophers*, insisting in the steps of *Plato* constitute only two kinds of Motion; only in this they differ from Him, that what He calls [φορὰν, ἤ περιφορὰν], *Latin*, or *Circumlation*, They call [μετάβασιν, ἤ μεταβατικὴν κίνησιν] *Transition*, or *motion Transitive*: and what He names [ἀλλοίωσιν] *Alteration*, They denominate [μεταβολὴν] *Mutation*, or [μεταβλητικὴν κίνησίν] *Motion Mutative*; as *Empiricus* (2. *adverf. physic.*) hath judiciously observed.

(4) That *Epicurus* (as the same *Empiricus*, in the same place, attesteth) is chief of those Physiologists, who accounted the Motion of Transition as the Genus, and Mutation or Alteration as only the species thereof. And this upon irrefragable Reason. Forasmuch as Alteration is nothing else but the consequent of Local motion, whereby Atoms, or the insensible particles of Concretions usually accede, decede, concur, complicate, and change their former positions, so as to render the sensible parts or whole of them other than they formerly were. Which being considered, we are only to advertise farther, that the Argument of our præsent Enquiry, is not Motition as it is proper to Atoms, as they either concur to the first constitution of a body, or are disgregated at the dissolution thereof; in which respect it may comprehend Generation and Corruption: nor as they concur to the Augmentation of a body already constituted, or flye off from it, and by their decedence Diminish it, in which respect it may comprehend Accretion and Diminution: nor as they are variously transported, and so conduce to affect the same body with divers Qualities; in which respect it may include Alteration. Because concerning Motion under all these Terms and relations, we have sufficiently discoursed already, in places to which those considerations did genuinly refer themselves. But, our subject is *Motion as proper to a body Concrete, which sensibly changes the Place of its whole, or some sensible part.* For, herein motion plainly distinguisheth it self from mutation, that in *motion* the whole Body, V. G. of a man, or some sensible part thereof, as his hand or foot is translated from one place to another: but in *Mutation* only the insensible particles of a body, or any part thereof, change their positions and places, though the whole, or sensible parts thereof remain quiet.

Art. 5. *Epicurus's Definition of motion, to be the Remove of a body from place to place; much more intelligible and proper, than Aristotles, that it is the Act of an Entity in power, as it is such.*

The THIRD; that *Motion or Loco motion* (for, the common Notion, which every man conceives, so soon as he hears the word motion pronounced, unites them) *is much more intelligibly and properly defined* by *Epicurus*, to be [μετάβασις ἀπὸ τοῦ τόπου, εἰς τόπον] the *migration of a body from place to place:* than by *Aristotle*, to be *Actus entis potestate, quatenus est tale.* For as nothing can be more manifest than the one; so nothing can be more obscure than the other.

And yet if your curiiosity be great enough to furnish you with patience, while we endeavour to pick out the meaning of *Aristotle*, in that his ænigmatical

matical Definition; we advise you to reflect upon the whole syntax of those conceptions, from whence He seems to have deduced it. Know, therefore, that He conceived, that there are some things, which always possess, and inamissibly retain the perfection due to their nature; [ἐντελέχειά μόνον] *Perfecti-habitione*, or (as his Expositors commonly render it) *Actu solum*, in Act only: and others again, which are not indeed, without some perfection, but such as they are capable of losing, and may at the same time acquire another; so that they may be said to be [ἐντελέχειά καὶ δυνάμει] both in *Act* and *Power together*. For, He admits nothing to be meerly in Power; because He would not allow, either that matter can exist without Forme; or that any thing in nature can be altogether without some perfection. Now, those things, which are only in Act, must, according to His opinion, be no other but the Cœlestial Bodies; insomuch as they alone seem constantly and inamissibly to possess their Forme, nor can their substance or matter be conceived, to have a Capacity of receiving any other Forme whatever. But, those which are both in Act and Power at once, are all sublunary Bodies; insomuch as their substance, or matter so stands possest of some one Forme in Act, as that it still remains in a Capacity of being devested of that Forme, and invested with a new one; and the whole Compositum so hath its certain Quantity, certain Quality, certain Place, and whatever other (if there be any other) perfection requisite to its particular nature, as that it may notwithstanding be totally deprived thereof, and obtain another. Know also, that He useth the word, Ἐντελέχειά, sometimes for the perfection already acquired; sometimes for the very manner of its acquisition, in which sense it is a certain Action, and so comes to be called [Ἐνέργεια] an Energy; This being præsupposed; He infers, that Motion is [Ἐντελέχειά] an Act, according to the posterior mode: understanding it to be as it were the Way, or manner, whereby the perfection is acquired, or the Acquisition it self: which is also a certain perfection, but competent to an Entity, or moveable, not as it hath a perfection, which it loseth; but as it hath a Power to that, which it receiveth. And hence is it, that He resolved to define Motion to be *the Act of an Entity in Power, as it is such.*

Art. 6. *Empericus* his *Objections* against that Definition of *Epicurus*: and the full *Solution* of each.

Which notwithstanding all the light this our most favourable Descant, or any other can cast upon it, is yet much inferior in Perspicuity to that most natural and familiar one of *Epicurus*; that Motion is *the migration or Remove of a body from one place to another.* Nevertheless, to verifie that unhappy proverb, that no Truth can be made so plain, as not to be impugned; *Empericus* (2. *adverſ. phyſic.*) hath charged it with sundry Imperfections. As

(1) That it doth not comprehend the motion of a Globe, or wheel circumvolved upon its Axis; forasmuch as a wheel, when circumgyrated upon its Axe, is sensibly moved, but not removed from one place to another. But to this we may readily *Answer*; that though the whole wheel be not removed out of its whole place, yet are the Parts of it sensibly transferred from place to place; the superior descending to inferior, while the inferior ascend to superior places, the right hand parts succeeding into the places of the left, as fast as the left succeed into those of the right, and all parts successively shifting their particular places. And upon this distinction of Place into *Total* and *Partial*; was it that some Philosophers have Defined

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motion to be *Migrationem de loco in locum, vel totius corporis, vel partis ipsius*; or, as *Chrysippus* and *Apollodorus* (*apud Stobæum, in Eccl. phys.*) *Mutationem secundum locum, aut ex toto, aut ex parte.* Nay, even *Plato* Himself seems to have had an eye upon the same Difference, when He said, that Local motion was conjunctly *Lation*, or *Circumlation.*

(2) That likewise the point of that arme of a Compass, which is fixed in the Centre, while the other is moved round, in the description of a Circle; is moved, but not removed out of its place: as is also the Hinge of a door, while the door is opened or shut. But, this Objection must soon yeeld to the same Response, as the former: since tis manifest, that the parts of the point of the Compass, and Hinge change their Partial places.

(3) That there is a certain sort (He adds, Admirable) of motion, to which the importance of Epicurus Definition doth not extend; which is thus made. Let a man, in a ship under sail, walk, with a staff in his hand, from the forecastle to the poup of the ship; and with just so much speed, as the ship is carried forward: so that in the same space of time, as the ship is moved a yard forward, the man and the staff in his hand may be moved a yard backward. This done (saith He) doubtless there must be a motion both of the man and his staff; and yet neither of them shall be moved into new place, either as to their whole, or their parts: because both must remain in the same parts of the Aer, and Water, or in the same perpendicular line extended from the mans head to the bottom of the Sea; or, what is the same thing, they shall still possess the same Immoveable space. But, this so admirable Difficulty lies open to a double solution: for it may be *Answered.* (1) That in this case, the Thighs, Leggs, and feet of the man walking upon the deck of the ship, must be alternately moved into new places; because, as often as each of his feet is referred from the Anterior to the Posterior part thereof, it must be moved twice as swiftly, as the ship is moved from the Posterior toward the Anterior: since it is absolutely necessary, that the double velocity of one foot should compensate that space of time, in which the other foot resteth, while the ship is constantly carried forward in one uniform tenour of motion. And, therefore, his feet may be conceived, to be alternately moved from place to place; after the same manner, as a man, sitting on a wooden, or standing Horse, doth move his leggs alternately forward and backward: the trunck and upper part of his body remaining unmoved, or still keeping the same Centre of Gravity. (2) That the Trunck of his body also must be moved from place to place; and also his head, and the staff in his hand: because, at every step, all of them must be somewhat elevated, and again depressed, or let down. For, in progression, the feet of a man cannot be alternately moved forward, but at every time the one foot is set plainly upon the ground, the trunck and so the head and arms, must sink a little downward; in regard of the Distension of the muscles of that thigh and leg: and again when the other leg is advanced, and the leg upon which the whole body resteth the while, is elevated upon the toes, to cast the body forward; the trunck, head and shoulders are lifted a little upward; in respect of the bodies inclining to a new Centre of Gravity.

Gravity. For, it is most true, what *Galilæo* hath most subtly Demonstrated, that *a man goes, because he falls:* since he could not advance forward, while he kept his body æquilibrated upon the same Centre of Gravity; but falling forward at each step, he sustains himself with the fixing another foot upon a new Centre of Gravity.

(4) That if we suppose an Individual, or smallest thing to be turned round in the same place; there will be motion, but no change of place, either as to the whole, or any part thereof. And we Demand, whether by that Individual He means *minimum mathematicum*, or *Physicum?* If *Mathematical*, the supposition is not to be admitted: because, what is meerly Imaginary is not capable of motion. But, if *Physical*; then admitting the supposition, we *Answer*; that the reason of the motion of an Individual moved round in the same place, is the same with that of the motion of a Globe or wheel upon its Axis. For, such a body is not said to be Individual, or smallest, because it hath no magnitude or parts designable by the minde; but because there is no force in nature, that can divide and resolve it into those parts: and therefore, since it is not a meer point, but contains parts superior, inferior, &c. the whole cannot be moved, but some parts must succeed into the places deserted by others; and consequently there must be Loco-motion. Though this also be of the number of such Events, as can hardly be effected by the power of Nature; forasmuch as such a physical Individual being either permitted to its own liberty, would move spontaneously in a direct line, not a circular; or impulsed by another, could not be so exactly circumvolved in a Circle, as not to deflect somewhat, more or less, to one side or other. And thus have we Resolved all the Difficulties, by *Empericus*, objected to the Definition of Motion, given by *Epicurus*.

But yet we have not ascertained our Reader, *that there is such a thing as Motion in the World*; and therefore, that we may not seem to be meerly Petitionary, in begging that at the hand of another mans charitable Belief, which the stock of our own Reason is rich enough to afford us: we shall briefly touch upon that Quæstion; *An sit Motus*, Whether there be any Motion in Nature: Especially, forasmuch as it is very well known, that among the Ancients there was a notable Controversie concerning it. For, some, as *Heraclitus*, *Cratylus*, *Homer*, *Empedocles* and *Protagoras* (as *Plato* [*in theat.*] notes at large) affirmed, that All things in the universe are in perpetual *Motion*: and others, of which number *Parmenides*, *Melissus* and *Zeno* were the Principal, (as *Aristotle* (1.*physic.*) particularly records) Argued, on the contrary, that All things are in perpetual *Quiet*, or that there is no motion at all.

Art. 7. That there is motion; contrary to the Sophisms of *Parmenides*, *Melissus*, *Zeno*, *Diodorus*. and the *Scepticks*.

Now as to the *Former*; our Quarrel against them is not so great, as that of *Aristotle* was: forasmuch as it carries the face of very great probability that They intended no more than this; that All sublunary Bodies are in perpetual *Mutation* of their *Insensible* Particles, not *Loco-motion* of their *sensible* Parts, or Whole; or, more plainly, that all Concretions unceßantly suffer those irrequiet Agitations, or intestine Commotions of their insensible particles, from which those sensible Changes, Alteration, Augmentation, Diminution, Generation, and Corruption, are by slow and insensible degrees introduced upon them. And thus even *Aristotle* Himself inter-

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prets their opinion; saying (*in* 8.*phys.* 3.) they held, that All things are moved [ἀλλὰ λανθάνειν τοῦτο τὴν ἐμπειρίαν αἰσθήσεων] *verum id latere experientiam sensuum,* that that motion falls not under the observation of the senses. Which is no more, than what *Epicurus*, or any man else, imbued with his excellent principles, might have asserted.

And as for the *Latter* Sect; neither doth our Choler boyl up against them, to that height, as did *Sextus Empericus* his, when (*in* 2.*advers.physic.*) He could not be content to nickname them [Σταυτιώται] the *standers*; but so far obeys the impulse of his passion, as to fly out into opprobrious language, and brand them with the ignominious character of [Ἀφυσικοὶ] *Unnatural* Philosophers. And our *Reasons*, why we look not upon them with so oblique and indignatory an eye, as the Vulgar use to do; are these.

(1) Experience doth so clearly Demonstrate, that there is motion; as that no man can deny it, but he must, at the same instant, manifestly refute himself with the motion of his tongue. And such is the constant verity of *Epicurus* his Logical Canon, concerning the Certitude of our senses, as to the information of our mind; as that every Philosopher, nay every man ought to allow them to be judges in cases of sensible Objects: and consequently to conclude, with *Aristotle*; *ad mentis imbecillitatem debet referri, si quis arbitretur omnia quiescere, & dimisso sensu, rationem requirat.* And, certainly, whoso seriously impugnes, what the evidence of sense confirms; is so easie an Adversary, as to deserve our smiles, rather than our Anger.

(2) Divers have apprehended, that those Philosophers, who seemed to impugn the being of Motion, did not oppose it in a serious, but purely Paradoxical humor, and an ambition of shewing themselves so transcendently acute, as to be able to indubitate Truths even of the most manifest Certitude. Nor are They, indeed, to be understood in that gross sense, which is so generally passant among Vulgar Authors; forasmuch as it is much more probable, that *Parmenides* and *Melissus*, when they laid down for a maxime *Esse omnia unum Ens immobile*, so intended *Nature*, or the All of things, as that they held it, or at least some certain Divine Virtue constantly diffused through, and animating the vast mass of the Universe, to be *God*, or the *Supreme Being*; whose propriety it is to be *Immoveable*, as being Ubiquitary and All in All. And, that *Zeno* himself, the Prince of Antimotists, had some such meaning; may be naturally collected, as well from the Contents of that Book, commonly adscribed to *Aristotle*, concerning *Xenophanes*, *Zeno* and *Gorgias*: as from those very Arguments He alleadged against motion; the importance of them all declaring, that his supposition was, there could be no motion, if as well motion it self, as Place and Time did consist of *Insectiles*, or *Indivisibles*. Likewise, as for *Diodorus*, so fervently addicted to the Eristick, or Contentious Sect; manifest it is, that his grand scope in his whole Discourse against motion, was only to evince, that a good Wit could not want Arguments wherewith to invade and stagger the belief of a thing, than which nothing can be more certain. Lastly, as for the *Pyrrhoneans*, or *Scepticks*; the design of all their stratagems against motion, seems to have been only this innocent one: to insinuate that no knowledge is exempted from Doubts; and that the mind of

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man is obnoxious to so great infirmity, as to be able to raise such clouds of Dubitation, which its own dim light is not sufficient ever after to dispel again.

(3) But, granting them all to have been in Earnest, and to have aimed at the shafts of their Wit point blanck at the destruction of Motion; yet if we examine the sharpness of their best Arguments, we shall soon finde them not half so formidable, as most have, through incircumspection, conceived them. As for that Giant Difficulty urged against motion, by *Zeno*. which a long time wore the reputation of *Invincible*; please you but to reflect upon our Chapter of a *Vacuum Natural*, you may there meet with a full *Dissolution* of it. If that be too great a trouble to you; we dare undertake, your belief shall not miscarry, though you adventure it barely upon the Refutation of *Zeno*, by *Diogenes* the *Cynick*: who hearing him somewhat proudly object the same in the schools, only rose up and walked; as wisely conceiving that to be a sufficient, as well as the most ready Demonstration of the Contrary. As for the other Goliah Objection, excogitated and urged by *Diadorus*; it runs thus: *Si quidquam movetur, aut in quo loco est, movetur; aut in quo non est: at neque in quo est, in eo enim manet, si in ipso est; neque in quo non est, ubi enim quidquam non est, ibi neque agere, neque pati quicquam potest: quam obrem quicquam non movetur.* "If any thing be moved, it must be moved either in that place, wherein it "is, or in that wherein it is not: but not in that place wherein it is, be- "cause if it be there, it remains there; nor in that wherein it is not, because "nothing can either act or suffer there where it is not: therefore nothing "is moved. For, thus *Empiricus* (2. *adverf. physic.* 3. *pyrrhon. hypotyp.* 8. *& ibidem lib.* 2. *cap.* 22.) often præsents it; among other things seasonably commemorating, how pleasantly *Diodorus* was therefore derided by *Herophilus* the Physician. When *Diodorus* came to him, to entreat him to set his shoulder, that was out of joynt; *Herophilus* bad him be of good courage, since it was impossible his shoulder should be dislocated: for, saith He, either it was emoved in the place, wherein it was, or that wherein it was not; but in neither: and therefore it was not dislocated. Which *Diodorus* hearing, became conscious of his own sophisme, and entreated him to lay aside his subtleties and mirth, and address himself to his speedy cure. But to return to the Difficulty proposed; we observe, that it was impertinently done of *Diodorus* to make this Interrogation; Either in the place, wherein it is, or in that, wherein it is not: unless perhaps He meant the Common place of a thing, such as is a Hall, from one end whereof a man may walk to the other. In which case, it may be Answered, that the man walking, is moved in the place, wherein he is; for he is moved in the Hall, though not in the same part of the Hall. But, the Quæstion is not of the Common, but *Proper* place of a thing; and therefore the Interrogation ought to be, if any thing be moved, it must be moved either *from* this to that, or from this to another place: not *In* the place, wherein it is; or wherein it is not; since according to the true Notion of motion, we understand it to be the passing of a thing *from* one place to another. And consequently, the *Answer* is; that a body moved, is moved neither in the place, where it is; nor in that, where it is not: but from one place, wherein it was, through a place which it passeth, or pervadeth, to a third place, where yet it is not. Perhaps, you'l yet reply; as a thing passeth through a place, is it not in a place? And we shall rejoyn, that that very Quæry

doth detect the sophisme; for, since the word *Esse*, to *Be*, is, according to common signification, convenient as well to things Permanent, as Successive or Fluent; and according to a peculiarly accommodate signification, competent only to things Permanent: it is understood in the former sense, when the Quæstion is, *Either where it is, or where it is not?* and in the latter, when the subsumption is, *But neither where it is, nor where it is not:* according to which reason, you Doubt, Whether a thing *Be*, while it is moving. Which considered, when it is Enquired, whether a moveable be moved in the place, where it is, or in that, wherein it is not: we are to Distinguish thus; it is moved in the place, wherein it is *Transiently*, and moved in the place wherein it is not *Permanently*. And, to your Quæstion, Whether a thing be not in a place, when it passeth through a place? We Answer likewise, that it is in a place Transiently, not Permanently. Nor ought this Language to sound strange; since nothing ought to be conceived to be in any other manner, than what the Nature thereof doth præscribe: and such is the Nature of Motion, that it should be conceived to be [μεταβασις] a *Passing* through, not [παραμονη] a *Permansion*, or staying in a place. Lastly, as for the Arguments of the *Scepticks*; they are all grounded upon the same Difficulties as those of *Zeno* and *Diodorus*: and therefore must submit to the same Resolutions.

Sect. II.

Art. I. *Aristotles* Definitions of *Natural* and *Violent* motion; incompetent: and more adæquate ones substituted in the room of them.

BEing thus præpared with Considerations of the most Genuine Notion, most adæquate Definition, and Primary Cause of Motion in all Concretions; and an infallible assurance, that there is such a thing as Motion in the world: the next degree to which our Enquiry is to advance, is the more General and Principal KINDS thereof; among which, the First we meet with, is that common Distinction of motion into *Natural* and *Violent*.

A *Natural* motion, saith *Aristotle* (8. *physic.* 4.) is that, whose Principle is *Internal*; and a *Violent*, that, whose Principle is *External*: so that, accordingly, that Body may be said to be moved Naturally, which is moved by it self; and that Violently, which is moved by another. But, for as much as *Aristotle* himself doth much amuse us, while he ever and anon affirms, that one body may be moved by another, and yet not be moved violently; and that a motion may be said to be Natural or Violent, in more than one respect; and that some more easie and familiar Notion is to be accommodated to each of those Contrary Terms, Natural and Violent: therefore is it much more convenient for us, to understand a *Natural* Motion to be that, *which is made either of Natures own accord, or without any Repugnancy*; and a *Violent* to be that, *which is made either Præternaturally, or with some Repugnancy*. Thus, the Progressive motion of an Animal, is Natural, because made of Natures own accord; and yet if the Animal go through a bogg, climb a steep hill, leap, or run, the motion

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is to be accounted Violent, becauſe though it proceed from an Internal Principle, the Soul of the Animal, yet is it not performed without ſome Repugnancy, either internal or external. On the contrary; when a Bullet is ſhot through the aer, the motion thereof is violent, becauſe againſt the nature of the Bullet, and not performed without ſome repugnancy, either internal or external: and yet if the ſame Bullet be rowled upon a ſmooth plane, the motion thereof is Natural; becauſe though it be cauſed by an External Principle, yet is it performed without any Repugnancy either internal or External.

Art. 2. The ſame deduced from the *Firſt Epicurean* Principle of motion, præmiſed: and three conſiderable *Concluſions* extracted from thence.

But, that we may take the matter in a higher key, reflecting upon that ſo often inculcated Epicurean Principle, That all the motive Virtue of Concretions is originally derived from the mobility inhærent in, and inſeparable from Atoms, which compoſe them; let us obſerve, that foraſmuch as that eſſential mobility of Atoms doth neither ceaſe, but is only impeded, when Concretions themſelves begin to obtain a ſenſible Quiet; nor is produced anew, but only acquires more liberty, when Concretions begin to be moved: we may thence juſtly infer, *that juſt ſo much motive Force is now, and ever will be in the World, while it is a world, as was in the firſt moment of its Creation.* Which really is the ſame with that Rule of *Des Cartes* (*princip. philoſoph. part. 2. art. 36.*) *Deum eſſe Primariam omnis motus Cauſſam; & eandem ſemper motus quantitatem in univerſo perſeverare.* And Hence may we extract theſe notable *Concluſions.* (1) That, becauſe look how much one Atom, being impacted againſt another, doth impel it, juſt ſo much is it reciprocally impelled by it; and ſo the Force of motion doth neither increaſe, nor decreaſe, but, in reſpect of the Compenſation made, remains always the very ſame, while it is executed through a free ſpace, or without reſiſtence: therefore, *when Concretions, likewiſe mutually occurring, do reciprocally impel each other; they are to be conceived, to act upon, or ſuffer from each other, ſo, as that, if they encounter with equal forces, they retain equal motions on each ſide, and if they encounter with unequal forces, ſuch a Compenſation of the tardity of one, is made by the ſupervelocity of the other, as that accepting both their motions together, or conjunctly, the motion ſtill continues the ſame.* Which alſo is the ſame with that Third Law of Nature, regiſtred by *Des Cartes* (*princip. philoſoph. part. 2. art. 40.*) *Quod unum Corpus, alteri fortiori occurrendo, nihil amittat de ſuo motu: occurrendo, vero minus forti, tantum amittere: quantum in illud transfert.* (2) That foraſmuch as Atoms conſtantly retain their motive Virtue even in the moſt compact and hard Concretions; therefore *can there be no Abſolute Quiet in Nature:* the Atoms unceſſant ſtriving for liberty, cauſing perpetual Commotions in all things, though thoſe Commotions be inteſtine and inſenſible as we have often ſaid. Which conſidered, *Heraclitus* ſeems to have been more reaſonable, in his Denial of all Quiet, but to the dead (*apud plutarch. 1. placit. 23.*) than moſt have hitherto allowed: He underſtanding by the Dead, not only Animals deprived of life, and conſequently of motion; but alſo all other things Diſſolved, ſince then, and only then, the inteſtine Commotions of their Component Particles, or Atoms, ceaſe. (3) *That Motion is not only much more Natural than Quiet, in the General; but alſo always Natural, in reſpect of its Original, foraſmuch as it proceeds from Atoms, which are moved by their own Nature, or eſſentia Gravity: and ſometimes Violent, but ever ſo only at ſecond hand, or from the nature of Concretions, as they are moved with a certain Repugnancy.* And this Rule hath al-

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ſo a parallel in *Des Cartes*, viz. *Non plus Actionis requiri ad motum, quam ad Quietem* (*princip.philoſoph.part.2.art.26.*) Nor ought it to ſeem ſtrange that we admit ſomething to be *Violent* in Nature; becauſe, though in reſpect of the Univerſal Nature, nothing may be accounted Violent: yet, in reſpect of *Particular Natures*, there may. For, if you conceive it to be *Natural*, that many things in Nature ſhould be *Generated*: you muſt alſo conceive it to be equally *Natural*, that as many things in Nature ſhould be *Corrupted*; and conſequently, that they ſhould be moved *violently*, i. e. with Repugnancy to their Particular Natures. Furthermore, notwithſtanding the Voluntary motion of an Animal be vulgarly conceived to be Natural; yet whoever ſhall conſider, that Animal motion is always accompanied with a certain Labour, and attended on by Wearineſs, which by degrees encreaſeth upon Animals, in long, or great and quick motions; and that ſtrong impaction made againſt the joynts of one member by the bones and ligaments of another, and of all upon the *Spina Dorſi*, as alſo of the whole body of the Animal againſt the ground, on which it treads: we ſay, whoſo duly conſiders theſe things, will ſoon be induced to allow, that ſuch motion is always commixed with ſome *Violence*. And what hath been here ſaid of Motion, carries the ſame weight, if applied alſo to *Quiet*; foraſmuch as Quiet may be underſtood to be *Violent* in one ſenſe, and *Natural* in another. And, therefore, we ſhall only add this concerning Quiet; that it is Natural not only to the whole World, that it ſhould maintain a certain Cohæſion, or Conſiſtence, or Quiet of all its parts; but alſo to every ſingle part of the Univerſe, or every particular body; becauſe unleſs the parts ſenſibly quieſce in the Whole, i. e. be not Diſſociated from the Whole, no Concretion or Compage of matter could ſubſiſt. We ſay, *Quiet in the Whole*, not præciſely in *Place*; becauſe the Whole may be moved, and yet this or that particular part thereof ſo cohære unto it, or acquieſce in it, as that though it change place together with the whole, yet as to it ſelf, it may be no more moved, nor feel more Repugnancy, than if the whole did acquieſce, and it continued ſtill in the ſame place therewith.

Art. 3. A ſhort ſurvey of *Ariſtotles* whole theory concerning the Natnral motion of *Inanimates*: and the *Errors* thereof.

Now, though the Difficulty is not great, which concerns the motion of Animals; in reſpect of that Inequality and Painfulneſs that accompany, aud Laſſitude that uſually ſucceeds upon it, all which as we have even now inſinuated, import it to be commixt with ſome Violence: yet that ſeems to be a very conſiderable one, which concerns the motion of *Inanimates*, foraſmuch as moſt men, inſiſting in the Doctrine of *Ariſtotle*, apprehend it to be *Naturrl*. It follows therefore, that we henceforth addreſs our Enquiry chiefly to the motion of Inanimates; as that which may beſt evince the Impropriety of *Ariſtotles* Definition of Natural Motion to be that, whoſe Principle is Internal: wherein that we may be ſufficiently circumſpect, it behooves us to take a ſhort ſurvey of his whole Theory, touching that ſubject.

In the firſt place, He poſitively affirms, that whatever is moved, or doth move, is moved either *Per ſe*, or *per Accidens*: ſubjoyning, that what is moved *per ſe*, is the ſubject, or wlole; and what is moved *per Accidens*, is an Accident of the Subject, or Part of the Whole. For Inſtance; when a man, in whom are Muſick and a Soul, walketh; the man is moved per ſe, becauſe he is the ſubject and the whole: but the Muſick, which is in him, is

is moved per Accidens, becauſe it is an Accident to him; and likewiſe his ſoul is moved by Accident, becauſe it is only a Part of him. Again, when He teacheth, that whatever is moved, is moved by *Another*; that ought to be underſtood of that thing, which is moved *per ſe:* for, from hence it is, that when in the ſeries of particular movents, He would have us to come at length to one *Firſt Movent*, which is Immoveable, or which is not moved by any other; we are to underſtand that *Primum Movens* to be *Immoveable per ſe*, ſince it may be moved *per Accidens*. Thus, when a ſtone is moved by a ſtaff, the ſtaff by the hand of a man, the mans hand by his Soul; the ſoul, indeed, is the Firſt movent and Immoveable: but, underſtand it to be ſo, *per ſe*, becauſe it is at the ſame moment moved *per Accidens*, i. e. when the hand, arme, and whole body, which contains it, is moved. Moreover, He declares, that whatever is moved *per ſe*, is moved *juxta Naturam*, according to Nature; ſuch as he affirms that only to be, which is endowed with a ſoul: yet will He not admit, that what is moved by Another, ſhould always be moved *Præter Naturam*, Præternaturally; but ſometimes Unnaturally (as a ſtone, when it is thrown upward) and ſometimes Naturally (as a ſtone, when it falls Down again.) Now, if you hereupon Demand of Him, What that is, which makes a ſtone fall Down again; He ſhall Anſwer, that what moves it Downward, *per ſe*, is the Generant it ſelf, or that which firſt Produced the ſtone: and that which moves it downward, *per Accidens*, is that which removes the impediment or obſtacle to its deſcent, as the hand of a man, or other thing ſupporting the ſtone. And, if you again enquire of him, What is the Difference betwixt the Upward and Downward motion of a ſtone, how one ſhould be Violent, and the other Natural, ſince, according to his own Aſſertion, both are Cauſed by another: His Return will be, that the Difference lies in this, that the ſtone is not carried upward, of its own Nature, but Downward; as having the Principle of its Deſcent, inhærent in it ſelf, but not that of its Aſcent. If you urge Him yet farther; ſince the ſtone hath in it ſelf the Principle of its Motion, why therefore is it not moved only by it ſelf, but wants Another, or *External Motor?* His Anſwer will be: that there is a Twofold principle of motion, the one *Active*, the other *Paſsive*; and in the ſtone is only the Principle Paſſive, but in the External Motor is the Active. When yet it may be farther preſſed; that ſince according to his own Doctrine, the Paſſive principle is the *matter*, and the Active the *Forme:* as to the matter, that cannot be the principle of its motion Downward, no more than of its motion upward; and as for the Forme, if that be neither the Active principle, nor the Paſſive (as he will by no means admit) certainly there can be none. Which for Him to allow, were plainly to deſtroy his own great Definition of *Nature*, wherein He acknowledgeth it to be the *Principle of Motion*. But, alas! theſe are but light and venial Miſtakes, in compariſon of thoſe groſs Incongruities that follow.

Art. 4. Uniformity, or Æquability, the proper Character of a *Natural* motion: and the want of uniformity, of a *Violent*.

When *Ariſtotle* comes to handle the *Species*, or ſorts of Natural Motion, you may remember, that He firſt Diſtinguiſheth Natural motion in *Direct* and *Circular*; and then ſubdiſtinguiſheth the *Direct* into (1) that which is from the Circumference toward the Centre, or from the Extrems toward the middle of the world, which He calls *Downward*; and (2) that which is from the Centre toward the Circumference, which He calls *Upward:* aſſigning the former, or Downward motion, only to *Heavy* things, to the Earth ſimply, to Water and mixt things, *Secundum quid*; and the Upward only

only to *Light* things, to Fire ſimply, to Aer *Secundum quid*, and to mixt bodies, according to the greater or leſs prædominion of Fire in them, over the other Elements. And, as for the *Circular* motion, which is neither toward, nor fromward the Centre or middle of the world, but round about it; He aſcribes that only to the Cæleſtial Orbs, as being things neither Heavy, nor Light. But, foraſmuch as He doth not make it in the leaſt meaſure Evident, whether or no all theſe Things are moved by an Internal Principle, nor whether with ſome, or without all Repugnancy; and ſo leaves us ſtill to doubt, whether their Motions be Natural or Violent: are we not conſtrained, to omit all thoſe Ambages, and Difficulties, that attend upon this His imperfect Doctrine, and (with *Galilæo*) to have recourſe to ſome ſuch *Criterion* or *Character* of *Naturalneſs* in motions, as ſeems moſt conſentaneous to truth, becauſe moſt Evident? Doubtleſs, as the motion of Atoms, which is moſt Natural, is moſt Uniform, or Equal; ſo alſo in Concretions, by how much every motion is the more Natural, by ſo much more doth it appear to be Uniform, or Æqual. And therefore this *Uniformity*, or *Æquability* may be aſſumed as the trueſt Character of *Natural* motion: as we may eaſily conclude, that every Uniform motion is purely Natural, as on the contrary, that every motion, that wants Uniformity, is *Violent*. This may be Confirmed by that common maxime, *that nothing Violent can be Perpetual*; foraſmuch as the root of *Perpetuity*, is *Uniformity* (for, nothing in nature can either by growing ſtronger receive perpetual Increment, or by growing weaker endure perpetual Decrement) and upon conſequence, Inæquability, as being oppoſite to Perpetuity, muſt be the pathognomonick, or proper and inſeparable ſign of a Violent thing, and Æquability of a Natural. Hence, as for the *Cæleſtial motions*, they are argued to be *Natural*; becauſe they are *Uniforme*, and therefore *Perpetual*. And, aſſuredly, where the wiſe Creator of the World, would have any motion Perpetual; He ordained it to be Circular: as that, which being equally diſtant from the Centre in all parts, and wanting both beginning and end, might be continued with one conſtant tenour, and alſo unceſſantly. And as for *Direct* motions, or ſuch as are competent to Heavy and Light Bodies, whether Elements or mixt; they are on the contrary, to be judged to be *Violent*, in that they are very Unequal, and of little or no Duration. To inſiſt upon that of *Fire*, which periſheth in the ſame moment wherein it is produced, we need not; nor upon that of *Aer*, which is variouſly moved, ſometimes upward, ſometimes downward: becauſe even our ſenſe aſſures, that their motions are very Unequal. And, as to that Downward motion of *Earth*, and *Water*, and generally of all *mixt* Bodies, commonly accounted *Heavy*; we need only this ſhort obſervation: that their Motion is not only very ſhort, both as to Time and Space; but alſo ſo unequal in it ſelf, and of ſuch vaſt Acceleration in its progreſs, as that, if it might be conceived capable of longer Continuation, there is no Body in nature ſo Compact and Firme, which would not be ſhivered in pieces, and wholly be Diſſolved and Diſſipated thereby, in a ſhort time. And who will not readily admit that to be a moſt evident note of Violence? Since no man can conceive that motion to be Natural, which is comparated not to the Conſervation, but inevitable *Deſtruction* of Nature: but only He, who can admit, that the very Nature, or Formal Conſtitution of a thing, hath no Repugnancy to Deſtruction. But, you'l ſay (we ſuppoſe) muſt then the Principle of all motion, competent to Heavy Bodies, be *External*? Truely, it muſt; and you know, that we have already declared, that *Ariſtotle* allows it ſo to be.

be. What then, must that Ext ernal Principle be, as *Aristotle* contends, the very *Generant* of the thing move d? Certainly, thats highly Absurd; since the Generant is absent, and perhaps, long since ceased to be in *rerum natura*: and nothing either Absent, or Nonexistent, can be the Efficient of a Natural Action, such as motion is. If you will have, that to be moved by the Generant, signifies no more than *to receive a Virtue or Power of moving it self, from the Generant*; then while you endeavour to save *Aristotle* from the former *Absurdity*, you præcipitate him into a gross *Contradiction* of his own Doctrine: for, since the Generant it self ought to be moved by its Generant, and that again to be moved by its Generant, and so upward along the whole series of Generants, till you arrive at length at some First Generant, from whence that Virtue was first derived; you bring *Aristotle* to allow a *First* Generant, which impugns his fundamental supposition of the *Eternity* of the World. Nay, if you admit God to be the Author of the First Generant, it will then follow, that God must be the Cause of this particular motion, and not the First Generant, no more than the Last. Finally, is that the Cause, which only removes the *Impediment* to a Heavy bodies Descent? Neither is that Reasonable; for, as *Aristotle* himself confesseth, such a Cause is only a Cause by *Accident*.

Art. 5. The Downward motion of Inanimates, derived from an *External* Principle; contrary to *Aristotle*.

Seeing, therefore, that the Downward motion of a Heavy Body doth not proceed from any Internal Principle, nor from either its Generant, or that Accidental one, which removes the Impediment to its Descent, in the supposed Capacity of an External: let us proceed to enquire, Whether there be not some other *External Cause*, whereupon we may reasonably charge that Effect. Which that we may do with the more both of order and plainness; it is requisite, that we first remember, how Philosophers constitute divers *sorts* of Violent, or Externally-caused motion. *Empericus* (2. *adverf. physicos.*) makes 4 distinct species thereof, viz. *Pulsion*, *Traction*, *Elation*, *Depression*. And *Aristotle* sometimes superads a fifth, namely *Collision*; sometimes disallowing *Empericus* his Division, affirms that the species of motion, made by an External principle, are *Traction*, *Pulsion*, *Vection*, and *Volutation*: upon good reason reducing Elation and Depression to either Traction or Pulsion; forasmuch as a body may be elevated, or depressed by either Traction or Pulsion. But, yet He hath left us rather a Confusion, than logical Discrimination of the species of Violent motion; for, Collision and Pulsion are one and the same thing; and Vection may be performed either by Pulsion or Traction, insomuch as the thing movent doth not forsake the thing pulsed, or drawn, but constantly adhæreth unto it: and as for Volutation; it is both Pulsion and Traction at once, as may be easily conceived by any man, who seriously considers the manner thereof. Nay, Traction it self may be justly reduced to Pulsion; forasmuch as the movent, which is said to Draw a thing, doth, indeed, nothing but Impel it, by frequently reiterated small strokes, either directly toward it self, or to a lateral region: and yet notwithstanding, for plainness sake, and the cleerer Demonstration of our præsent thesis, we judge it convenient, to conserve the Common Notion, and to determine, that all Motion impressed upon one body by another, is performed, in the General either when the movent *Propels* the moveable *from* it self, or *Attracts* it *toward* it self. For, albeit the movent sometimes propels the thing moved from another body, or attracts it to another; yet can it not possibly do that, but it must, at the same time, either Avert it, in some measure, from, or Adduce it toward it self. Nevertheless, it is not to be denied, but Pulsion is

always the Chief Species; and for that consideration alone is it, that *Projection* (which is only *Impulsion*, or, as *Aristotle* emphatically calls it, a *more Violent motion*) is generally accepted as synonymous to Violent motion; and that Philosophers seldom or never Exemplifie Violent motion, but in *Projectills*, whether they be projected upward, or downward, tranversly, obliquely, or any way whatever.

Art. 6. That that External Principle, is the Magnetique *Attraction* of the Earth.

These things considered, it follows of pure necessity, that the Downward motion of Heavy Bodies, being caused (not by any Internal, but) by an External Force impressed upon them, must be effected either by *Impulsion*, or by *Traction*. By *Impulsion* it cannot; because, in the case of a stone thrown Upward, there is nothing External, that can be imagined to impel it Down again, after it hath attained the highest point of its mountee, unless it should be the Aer: and if its Descent did proceed from the impulse, or depressive force of the Aer circulated from below upon the upper part of the stone; then in the projection of the stone upward, during its Ascent, the motion thereof would, in every degree of its remove from the projicient, be Accelerated in the same proportion, as its Downward motion is Accelerated, in every degree of its descent; but Experience testifies, that its upward motion is more and more Retarded, in every degree of its remove from the projicient, and therefore it cannot be, that the Downward motion thereof should be caused, nay not so much as advanced by the Aer. Which thing *Gassendus* (*in* 1 *Epist. de proport. qua Gravia decidentia accelerantur*) hath copiously demonstrated; and we our selves, out of him, *in the* 9 *Article of our* 2 *Sect. concerning Gravity and Levity, in the* 3. *Book. præcedent.* What, therefore, can remain, but that it must be by ATTRACTION? And, because no other Attractive Force, which might begin and continue the Downward motion of a stone, can be imagined, unless it be that *Magnetique Virtue of the Earth*, whereby it Draws all Terrene Bodies to an Union with it self, in order to their, and its own better Conservation: we may lawfully Conclude, *that the Cause of the Downward motion of all Heavy Bodies, is the Magnetique Attraction of the Earth.* Nor need we adferr other Arguments, in this place, to confirm this Position; in respect we have formerly made it the chief subject of the 2 *Sect. of our Chap. of Gravity and Levity*; whether we, therefore, remit our unsatisfied Reader.

Art. 7. That the *Upward* motion of *Light* things, is not *Accelerated* in every degree of their Assent as *Aristotle* præcatiously affirmed: but, the *Downward* motion of *Heavy* things is *Accelerated*, in every degree of their Descent.

From the Cause of the Downward motion of Heavy bodies, let us advance to the *Acceleration* of them, in every degree of space, through which they Fall: there being no considerable reason, why we should at all enquire into the Acceleration of the *upward* motion of *Light* bodies, in every degree of their Ascent; forasmuch as we know of no man, but *Aristotle*, that ever durst affirm, that the motion of Fire, and Aer is slower in the beginning, and gradually swifter and swifter in the progress. And so short was He of proving that his singular conception, by Experiment, as he ought; that he assumed it upon the credit of only one poor Argument, which is this. "If Fire, and Aer, and other things of the like light and aspiring "nature, saith He (1 *de Cælo. cap.* 8.) were Extruded and Impelled up-"ward, by other heavier bodies descending and crouding toward the mid-"dle of the world, with greater force, as some have contended; and were "not carried upward by the spontaneous tendency of their own inhærent "Levity: then would they be moved more swiftly in the beginning, and "more slowly in the end of their motion; but Fire, and Aer are more "slow in the beginning, and more and more swift in the progress of their "Assent

"Assent; therefore are they not moved upward by the Extrusion and Im-"pulsion, but spontaneously, or by their own Levity. And to Confirm his *Minor* proposition, that Fire and Aer are Accelerated in every degree of their Assent; without the suffrage of any Experiment, He subjoyns only, "that as a Greater quantity of Earth is moved downward more swiftly, "than a less; so is a Greater quantity of Fire moved upward more swiftly "than a less: which could not be, if either of them were Impelled, or mo-"ved by an External Force. But, this is, as the Former, meerly *Petitionary*; for, why should not a Greater quantity of Earth, or Fire be moved more swiftly than a less, both being moved (as we suppose) by External force, in case the External force be proportionate to the quantity of each? Doubtless, the force of the ambient Aer, extruding and impelling flame upward, is always so much the greater, or more sensible, by how much more Copious the Fire is; as may be evinced even from the greater Impetus and waving motion of the flame of a great fire: though it cannot yet be discerned, whether that Undulous or waving motion in a Great flame be (as He præsumes) more swift aud rapid, than that more calm and equal one observed in the flame of a Candle. This (you'l say) is enough to detect the incircumspection of *Aristotle*, in assuming, upon so weak grounds, that the motion of Light things Ascending, is accelerated in the progress, and that in the same proportion, as that of Heavy things Descending is accelerated: but not enough to refute the *Position* it self; and therefore we think it expedient, to superad a Demonstrative Reason or two, toward the plenary Refutation thereof. Seeing it is evident from Experience, that a Bladder blown up is so much the more hardly depressed in deep water, by how much neerer it comes to the bottom; and a natural Consequent thereupon, that the bladder, in respect of the Aer included therein, beginning its upward motion at the bottom of the Water, is moved toward the region of Aer so much the more slowly, by how much the higher it riseth toward the surface of the Water, or lower part of the region of Aer incumbent thereupon; and that the Cause thereof is this, that so much the fewer parts of Water are incumbent upon the bladder and aer contained therein, and consequently so much the less must that force of Extrusion be, whereby the parts of Water bearing downward impel them upward: we may well infer hereupon, that if we imagine that any Flame should ascend through the region of Aer; till it arrived at the region of Fire, feigned to be immediately above the region of Aer; that Flame would always be moved so much the slower, by how much the higher it should ascend, or by how much the neerer it should arive at the region of Fire. Because Fire and Aer are conceived to be of the same aspiring nature: and because the same Reason holds good, in proportion, for the decrease of Velocity in the ascension of Flame through the Aer, as for that of the decrease of velocity in the ascension of Aer, included in a bladder, through Water. And, as for *Aristotles* other relative Assertion, that *a Greater quantity of Earth is moved more swiftly Downward, than a Less*; manifest it is, that He meerly usurped the concession of this also, without, nay contrary to the suffrage of Experiment. For, an easie Experience doth demonstrate that a stone, or bullet of an hundred pound weight, doth not fall down more swiftly, or sooner arrive at the ground, than another of only an ounce weight, both being together præcipitated from the same altitude: which may seem Paradoxical indeed; especially to those, vvho being educated at the feet of *Aristotle*, conceive that Gravity is a Quality

inhærent in bodies accounted Heavy, and that every body must therefore fall down so much the more swiftly and violently, by how much the more of Gravity it possesseth. Having thus totally subverted *Aristotles* erroneous Tenent, that the motion of Light bodies Ascending, is Accelerated in every degree of their Ascention: it follows, that we apply our selves to the consideration of the *Acceleration of the motion of Heavy bodies Descending, in every degree of their Descention.* Wherein the First observeable occurring, is the *Quod sit*, or *that it is so*, which is easily proved from hence, that in all ages it hath been observed, that the motion of Heavy things Descendent, is slower in the beginning, and grows swifter and swifter still toward the end, so as that in fine it becomes highly rapid: experience attesting, that the blow, impulse or impression made upon the Earth, by a thing fain down from on high, is always so much the greater or stronger, by how much the higher the place is from which it fell.

Art. 8. The *Cause* of that Encrease of Velocity in Bodies descending; *not the Augmentation of their Specifical Perfection as they approach neerer and neerer to their proper place*: as *Simplicius* makes *Arist.* to have thought.

The *Second*, is the *Cur sit*, or *Cause* of that velocity Encreasing in bodies Falling; which though enquired into by many of the Ancients, seems yet to have been discovered by none of them. For (1) albeit *Aristotle* Himself was so wary, as not to explicate his thoughts concerning it; yet doth his great Commentator, *Simplicius* tell us (*in Comment.* 87.) that it was His opinion, that a stone, or other thing falling from on high, is Corroborated [ἀπὸ τῆς οἰκείας ὁλότητος] *à Totalitate propria*, and hath its species made more and more perfect, as it comes neerer and neerer to its proper place; and so that a new degree of Gravity acceding to it in every degree of its appropinquation to the Earth, it is accordingly carried more and more swiftly. But, seeing that *Simplicius* hath not expounded, how the whole stone can act upon itself; how it can be Corroborated, or acquire more and more perfection of its species; or how that additament of fresh Gravity should arise unto it: judge you, whether He hath done *Aristotle* any right, in making him the Author of that Opinion, which instead of explaining the matter, leaves it much more obscure than afore. Besides, we have the certificat of Experience, that a descending body is not carried the more swiftly, by reason of any access or additament of Gravity: a stone of an ounce weight, falling as speedily down, as one of an hundred pound.

Art. 9. Nor the Diminution of the quantity of Aer underneath them: as some *Others* conjectnred.

(2) Others there were (as the same *Simplicius* commemorates) who referred the Cause thereof, to the *Decrease of the quantity of the Aer underneath the stone*: conceiving, that by how much the higher a stone is, by so much the more of Aer is below it, and so much the greater Resistence to the motion of the stone, by how much the greater quantity of the Aer resisting; so that the quantity, and consequently the resistence of the Aer growing less and less, in every degree of the stones descent, the velocity of its motion must be gradually encreased in proportion thereunto. And this after the same manner as weights are carried, sinking in deep water, more slowly neer the top, and more swiftly neer the bottom. But, though we admit, that the subjacent Aer may somewhat resist a stone Descending; yet we deny the resistence to be so great, as to make any sensible difference of velocity in the parts of its motion. And, would you have an Argument to the purpose; be pleased to let fall a stone from the altitude of one fathom; and exactly observe the velocity of its motion. Then let fall the same stone, from the altitude of ten fathoms; and when it hath pervaded nine fathoms

fathoms, obſerve again with what velocity it paſſeth the laſt, or tenth fathom. This done, conſider, ſince in the latter caſe, the velocity ſhall be incomparably greater, than in the former; whether it be not neceſſary, that that great augmentation of velocity in the ſtone, while it pervadeth the tenth fathom of ſpace, muſt not ariſe from ſome other, and more potent Cauſe, than the reſiſtence of the inferior Aer? For, in both caſes, the ſtone carries the ſame proportion of weight; and in the loweſt fathom there is the ſame quantity of Aer, and conſequently the ſame meaſure of reſiſtence. And, if you weigh the ſtone, firſt in ſome very high place, and afterward in a low, or very neer the Earth; ſurely, you cannot expect to finde it heavier in the low place in reſpect of the leſſer quantity of Aer ſubjacent, than in the high, in reſpect of the greater quantity of Aer there ſuſtaining it. Laſtly, as for their Argument deſumed from the ſlower ſinking of weights in deep, than in ſhallow Water; the cauſe thereof is the ſame with that of the more difficult depreſſion of a Bladder blown up with Aer, neer the bottom, than neer the top of the Water, which we have lately explained.

Art. 10. Nor, the Gradual Diminution of the Force impreſt upon them, in their projection upward: as *Hipparchus* alleadged.

(3) A third Conceipt there is (imputed to *Hipparchus*, by the ſame *Simplicius*) which comparing the Downward motion of a ſtone, cauſed by its own proper Gravity, with the Upward motion of the ſame ſtone, cauſed by an External Force impreſſed upon it by the Projicient; thence infers, that as long as the force impreſt prævails over the ſtones Gravity, ſo long is the ſtone carried upward, and that more ſwiftly in the beginning, becauſe the Force is then ſtrongeſt, but afterward leſs and leſs ſwiftly, becauſe the ſame force impreſt is gradually debilitated, until the ſtones proper Gravity at length getting the upper hand of the force impreſt, the ſtone begins it motion Downward; which is ſlower in the beginning, becauſe the Gravity doth not yet much prævail, but afterwards grows more and more ſwift, becauſe the Gravity more and more prævails. But this leaves us more than half way ſhort of the Difficulty; for, though it be reaſonable to aſſume, that a certain Compenſation of Velocity is made in bothmotions, i.e. that the Decreaſe of Velocity toward the end of the Upward motion, is made up again by the Encreaſe of Velocity toward the end of the Downward, and that in proportion to the degrees of ſpace: yet foraſmuch as the motion of a ſtone falling down is conſtantly Accelerated, not only after it hath been projected Upward, but alſo when it is only dropt down from ſome high place, to which perhaps it was never elevated, but remained there from the beginning of the world, as it often happens in deep mines, the earth underneath the ſtones neer the ſurface of it being undermined; therefore cannot the ſtones Gravity, gradually prævailing over the Impreſt Force, be, as *Hipparchus* concludes, the Cauſe of its Encreaſe of Velocity in each degree of its Deſcent.

Art. 11. But, the *Magnetique Attraction* of the Earth.

Theſe Reaſons thus deluding our Curioſity, let us have recourſe to our formerly aſſerted Poſition, that *All terrene bodies Deſcend, only becauſe they are Attracted by the magnetique Virtue of the Earth.* Shall we conceive, that the magnetique Virtue of the Earth is more potent neer at hand, than afar off: and thereupon infer, that the downward motion of a ſtone is therefore more rapid neer the earth, than far from it; becauſe the magnetick Virtue ſeems to be greater, and ſo the Attraction ſtronger, by how much neerer the ſtone approacheth to the Earth? This certainly is obvi-

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ous and plausible to our first thought: but insatisfactory to our second. For, if it were so, then ought the Celerity of the stones motion, in one fathom neer the Earth, to be the same, whether the stone be let fall from the altitude of only one fathom, or from that of 10, 20, an 100 fathoms, when we exactly measure the space of time, in which it pervades the one fathom neer the earth, in the former case, and compare it with that space of time, in which it pervades the same lowest fathom, in the latter. It may be farther observed, that, whether a stone be let fall from a small, or a great altitude, the motion thereof for the first fathom of its descent, is always of equal velocity, i. e. it is not more nor less swift for the first fathom of its descent from the altitude of an 100 fathoms, than from the altitude of only two fathoms: when yet it ought to be more swift for the first fathom of the two, than for the first of the hundred, if the Attraction of the Earth be more vehement neer at hand, than far off; in a sensible proportion. We say, in a *sensible* proportion; because, forasmuch as the magnetique rays emitted from it, are diffused in round from all parts of the superfice thereof, and so must be so much the more dense, and consequently more potent, by how much less they are removed from it: therefore must the Attraction be somewhat more potent at little than at very great distance; but yet there is no tower or præcipice so high, as to accommodate us with convenience to experiment, whether the power of the Earths magnetique rayes is Greater, to a sensible proportion, in a very low place, than in a very high.

And yet notwithstanding, nothing seems more reasonable than to conceive, that since the magnetique Attraction of the Earth is the true Cause of a stones Downward motion, therefore it should be also the *true Cause of the continual Increment of its Velocity, during that motion.* But how it should be so; there's the Knot. Which that we may undo, let us first resume our former supposition (*in the 2. Sect. of our chap. of Gravity and Levity.*) that a stone were situate in any of the Imaginary spaces; considering that in that case it could not of it self be moved at all: because, holding no Communion with the World (which you may suppose also to be Annihilated) there could be, in respect thereof, no inferior place or region, whereto it might be imagined to tend or fall; nor could it have any Repugnancy to motion, because there would be no superior region, to which it might be conceived to aspire or mount. Then let us suppose it to be moved by simple Impulsion, or Attraction, toward any other part of the Empty, or Imaginary spaces; and without all doubt, it would be moved thitherward, with a motion altogether Equal or Uniform in all its parts: because there could be no Reason, why it should be more slow in some parts of its motion and more swift in others, there being no Centre, to which it might approach, or from which it might be removed. Suppose farther, that, as the stone is in that motion, another Impulse, equal in force to the former, whereby it was first moved, were impressed upon it; then, assuredly, would the stone be moved forward more swiftly than before, not by reason of any Affection to tend to any Centre, but because the force of the first impulse persevering, the force of the second impulse is superadded unto it, and the accession of that force must so corroborate the former, as to augment the Velocity of the stones motion. And hence comes it, that to move forward a body already in motion, doth not only prolong, but accelerate the motion thereof. Imagine moreover, that a third impulse were incontinently superadded to the second; and then would the motion be yet more

more ſwift than before; the Encreaſe of Velocity of neceſſity ſtill reſponding to the multiplicity of Impulſes made upon the body moved. This may be familiar to our conceptions, from the Example of a Globe ſet upon a plane; which may be emoved from its place with a very gentle impulſe, and if many of thoſe Impulſes be repeated thickly upon it; as it moves, the motion thereof will be ſo accelerated, as at length to become ſuperlatively rapid. Which alſo ſeems to be the Reaſon, why a clay Bullet is diſcharged by the breath of a man, from a Trunck, with ſo great force; as to kill a Pidgeon at 20, or 30 yards diſtance: the Impetus or force impelling the bullet, growing ſtill greater and greater, becauſe in the whole length of the trunck there is no one point; in which ſome of the particles of the mans breath ſucceſſively flowing, do not impreſs freſh ſtrokes, or impulſes upon the hinder part of the bullet. The ſame alſo may be given, as the moſt probable Cauſe, why Long Guns carry or ſhot, or bullet farther than ſhort; though yet there be a certain determinate proportion to be obſerved betwixt the diametre of the bore, and the length of the barrel or tube, as well in Truncks, as Guns: experience aſſuring, that a Gun of five foot, musket bore, will do as good execution upon Fowl, with ſhot, and kill as far, as one of ten foot, and the ſame bore; and conſequently that thoſe Gunners are miſtaken, who deſire to uſe Fowling pieces of above 5, or 6 foot long; Theſe conſiderations premiſed; we may conceive, that when a ſtone firſt begins to move downward, it then hath newly received the firſt impulſe of the magnetique rays emitted from the Earth: and that if after the impreſſion of that firſt impulſe, the Attraction of the Earth ſhould inſtantly ceaſe, and no nevv force be ſuperadded thereunto from any Cauſe vvhatever; in all probability, the ſtone vvould be carried on tovvard the Earth vvith a very ſlovv, but conſtantly equal and Uniform pace. But, becauſe the Attraction of the Earth ceaſeth not, but is renevved in the ſecond moment by an impulſe of equal force to that firſt, vvhich began the ſtones motion, and is again renevved in the third moment, in the 4, 5, 6, &c. as it vvas in the ſecond, therefore is it neceſſary, that becauſe the former impulſes, impreſſed are not deſtroyed by the ſubſequent, but ſo united as ſtill to corroborate the firſt, and all combining together to make one great force; vve ſay, therefore is it neceſſary, that the motion of the ſtone, from the repeated impulſes, and ſo continually multiplied Impetus or Force, ſhould be more ſwift in the ſecond moment, than in the firſt; in the third, than in the ſecond; in the fourth, than the third, and ſo in the reſt ſucceſſively; and conſequently, that the Celerity ſhould be Augmented in one and the ſame tenour, or rate, from the beginning to the end of the motion.

Art. 12. That the Proportion, or Ration of *Celerity* to *Celerity*, encreaſing in the deſcent of Heavy things; is not the ſame as the Proportion, or Ration of *Space* to *Space*, which they pervade: contrary to *Michael Varro* the Mathematician.

The Third thing conſiderable in this Downward motion of Bodies, is the PROPORTION, or Rate, in which their Celerity is encreaſed. Concerning this, we know of no Enquiry at all made by any one of the Ancients; only *Hipparchus*, as hath been ſaid, thought that in the General, the increment of Velocity in things falling down, was made in the ſame reciprocal proportion, as the Velocity of the ſame things projected upward. But, about 90 yeers paſt, one *Michael Varro*, an eminent Mathematician (*in tract. de motu.*) depending meerly upon Reaſon; would have the Problem to be thus ſolved. What is the Ration, or Proportion of ſpace to ſpace, the ſame is the Ration of Celerity to Celerity; ſo that if a ſtone falling down from the he igth of four fathoms, ſhall in the end of the firſt fathom acquire one

one degree of Velocity, in the end of the ſecond two, in the end of the third three, in the end of the fourth four: it will be moved twice as ſwiftly in the end of the ſecond fathom, as in the end of the firſt, thrice as ſwiftly in the end of the third, and four times as ſwiftly in the end of the fourth, as of the firſt. But, this Proportion is deficient, firſt in this; that though the increment of Celerity, or of its equal degrees, may be compared with the equal moments or parts of ſpace: yet can it not be compared alſo with the equal moments or parts of Time, without which the myſtery can never be explicated. And therefore *Ariſtotle* did excellently well, in Defining *Swift*, and *Slow*, by *Time*; determining that to be ſwift, *which percurs a great deal of ſpace in a little time*; and on the contrary, that to be ſlow, *which is pervading a little of ſpace in a great deal oftime*. Again, let us ſuppoſe the theorem to be explicable by equal moments of times, and ſuch as are the reſpites or intervals betwixt the pulſes of our Arteries; and that a ſtone falling down doth pervade the firſt fathom of ſpace, in the firſt moment: then, if it pervade the ſecond fathom twice as ſwiftly as the firſt (as *Varro* conceives) it muſt neceſſarily follow, that the ſecond fathom muſt be pervaded in the half of a moment; if the third fathom be percurred thrice as ſwiftly as the firſt, it muſt be pervaded in the third part of a moment;and if the fourth fathom be percurred four times as ſwiftly as the firſt, it muſt be pervaded in the fourth part of a moment.And,becauſe,if you conjoyn the half,third, and fourth part of a moment,you ſhall have a whole moment with one twelfth part of a moment; it will be neceſſary,that in the ſecond moment, three fathoms(very neer) muſt be percurred: which indeed is very far from truth. For,becauſe,if we proceed after the ſame method, ſo that the fifth fathom be percurred in the fifth part of a moment; the ſixth in the ſixth part of a moment, and ſo ſucceſſively; out of theſe fragments of time we ſhall not be able to make up another whole moment, until it be after the ſtone hath pervaded the eleventh fathom,or thereabout; and ſo in the third moment ſeven fathoms ſhall be pervaded, nor ſhall we again be able to make up another whole moment, until after the ſtone hath pervaded the 31 fathom; and ſo in the fourth moment, it ſhall pervade 20 fathoms, nor ſhall we be able to make up another complete moment, until after the ſtone hath pervaded, neer upon, the 84 fathom, and ſo in the fifth moment, 53 fathoms ſhall be percurred, &c. ſo that proceeding according to a triple proportion, neer upon; you ſhall conſequently, in a very ſhort time, increaſe it up to Immenſity: as is manifeſt from the ſhort progreſs through theſe numbers, 1. 2, 4, 11, 31, 84, &c. Which is impugned by eaſie Experience,and not defenſible by any Reaſon whatever.

Art. 13. But, that the moments or Equal degrees of Celerity, carry the ſame proportion, as the moments or equal degrees of *Time*, during the motion: according to the Illuſtrious *Galilæo*.

This the brave *Galilæus* well conſidering, and long labouring his ſubtle and active thoughts, to explore a fully ſatisfactory Solution of this dark Riddle; came at length moſt happily to ſet up his reſt in this. Firſt, He defines *Motion equally Accelerated* to be that, *which receding from quiet, doth acquire equal moments of Celerity, not in equal ſpaces, but equal Times*. Then proceeding upon Grounds partly *Experimental*, partly *Rational*; He concludes, that the moments, or equal Degrees of Celerity, are as the moments, or equal degrees of Time, or (more plainly) *that the Celerities carry the ſame proportions as the Times*; ſo that look how many moments of time paſs during the motion, ſo many degrees of Celerity, are acquired by the thing moved. That the equal ſpaces, which are percurred continently in ſingle moments of time, do encreaſe

encreaſe in each ſingle moment, according to the progreſſion not of Unities, but of Numbers unequal from an Unity: ſo that if in the firſt moment of time, the ſtone fall down one fathom, in the ſecond moment, it muſt fall down three fathom, in the third five, in the fourth ſeven, in the fifth nine, in the ſixth eleven, and ſo forward. And, becauſe thoſe Numbers, which they call *Quadrate* (viz. One is the quadrate of an Unity, Fower the quadrate of a Binary, Nine the quadrate of a Ternary, Sixteen of a Quaternary, and) are made up by the continual addition of unequal numbers (for, three added to one, make four; five added to four, make nine; ſeven, to nine, make ſixteen; nine to ſixteen, make twenty five; eleven to twenty five, make thirty ſix, &c.) thereupon He infers, that the Aggregates of the ſpaces percurred from the beginning to the end of the motion, are as the Quadrates of the times: i. e. aſſuming any one particular moment of time, ſo many ſpaces are found pervaded in the end of that moment, as are indicated in the quadrate number of the ſame moment. For Example; when in the end of the firſt moment, one fathom of ſpace is pervaded; in the end of the ſecond moment, four fathom ſhall be pervaded; (viz. three being added to one) in the end of the third moment, nine fathom (five being added to four) in the end of the fourth moment, ſixteen fathom (ſeven being added to nine) and ſo forward: ſo that, accordingly, the ſpaces pervaded from the beginning to the end of the motion, are among themſelves in a Duplicate Ration of moments (as Geometricians ſpeak) or equal Diviſions of Time; or, all one as the Quadrates of moments are one to another.

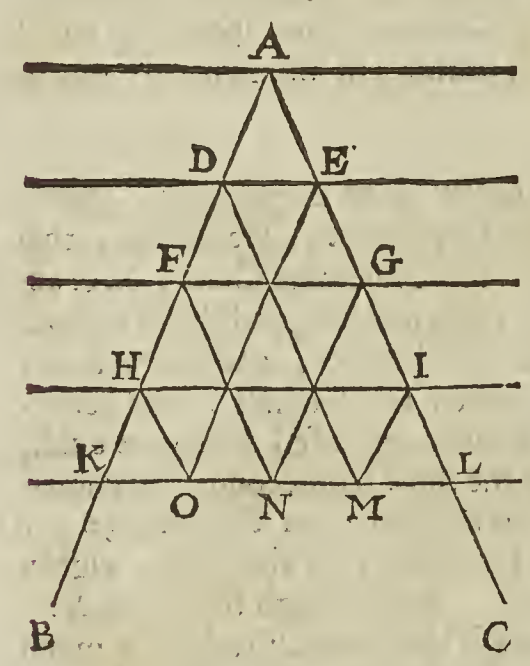
Art. 14. *Galilæo's* Grounds, *Experience* and *Reaſon.*

Galilæus, we ſaid, herein relyed partly upon Experience, partly upon Reaſon. Firſt, therefore, for his *Experience*; He affirms, that letting fall a Bullet, from the altitude of 100 Florentine Cubits (i. e. according to exact comparation, 180 feet, Paris meaſure, and thirty fathom of ours) He obſerved it to pervade the whole ſpace; and arrive at the ground, in the ſpace of five ſeconds, or ten ſemiſeconds: and according to ſuch a ration, as that in the firſt ſemiſecond, it fell down one cubit, in the ſecond ſemiſecond, four cubits; in the third ſemiſecond, nine cubits; in the fourth ſixteen; in the fifth twenty five; in the ſixth 36; in the ſeventh, forty nine; in the eighth, ſixty four; in the ninth, eighty and one; in the tenth the whole hundred. And though the good *Merſennus* afterward found a bullet to pervade the ſame altitude in a much ſhorter time; nay, that in the ſpace of five ſeconds, a bullet fell down through the ſpace not onely of one hundred and eighty foot, but even of three hundred, i. e. of fifty fathom: yet doth He fully conſent; that the Acceleration of its motion ariſeth exactly according to *Galilæos* progreſſion by the Quadrates of unequal numbers. So as that if in the firſt ſemiſecond, it deſcend one ſemi-fathom; in the ſecond ſemiſecond, it ſhall deſcend four ſemifathoms, in the third ſemiſecond, nine ſemifathoms, &c. And *Gaſſendus* likewiſe, though he wanted the opportunity of experimenting the thing, from a Tower of the like altitude; found notwithſtanding, from different heights, that the proportion was always the ſame; as Himſelf at large declares (*in Epiſt.* 1. *de proport. qua gravia decident. accelerantur.*) Nor need you doubt to find it ſo your ſelf, if in a Glaſs Tube, neer upon two fathom long, divided into an hundred degrees, or equal parts, marked with figures reſpectively either cut in, or inſcribed

upon papers (after the manner of those usually starcht on to Weather-glasses, to denote the several degrees) and not perpendicularly erected, but somewhat inclining, you let fall a bullet, and exactly observe the manner of its descent, and rate of Acceleration. For, Heavy bodies are, indeed, moved more slowly in Tubes inclined, than in such as are perpendicularly erected; but yet still with the same proportion of Acceleration.

Secondly, for His *Reason*, it consists in this; that, if the Increment of Velocity be supposed to be Uniforme (and there is no reason, which can persuade to the contrary) certainly, no other proportion can be found out, but that newly exposed: since, with what Celerity, or Tardity soever you shall suppose the first fathom to be pervaded it is necessary that in the same proportion of time following, three fathoms should be pervaded; and in the same proportion of time following, five fathoms should be pervaded; &c. according to the progression of Quadrate Numbers. This, that Great man *Joh. Baptista Ballianus* (whom *Ricciolus* often mentions (*in Almagesto novo*) but never without some honourable attribute) hath demonstrated divers ways *in lib.2. de Gravium motu.*): but the most plain Demonstration of the verity thereof, yet excogitated, we conceive to be this, invented by *Gassendus*.

Art. 15. The same Demonstrated.



Understand the Lines *L A B* and *A C I* making a rectangular Triangle, by their meeting at the point *A*, to be so divided, on each side, into equal parts, at the points *D E F G H I K L*: (being continued, they may be divided into many more) as that the Lines drawn both betwixt those points, and from them to the points *M N O*, divide the whole space *K A L* into Triangles perfectly alike and equal each to other. This done, Assume the point or Apex *A*, for the beginning of Time, the beginning of space, and the beginning of Velocity: All which are to be here considered in the motion, as beginning together with it. First, then we may account the equal parts of each Line, *A B*, *A C*. for the parts or equal moments of Time, flowing on from the beginning: so that *A E* may represent the first moment, *E G* the second, *G I* the third, *I L* the fourth. Secondly, we may account those equal Triangles, for the equal parts of the space, which are pervaded from the beginning: so that Another perpendicular Line *P Q*. being drawn apart, and representing the fall of a stone, through sixteen fathom, the triangle *A D E*, may refer the first fathom *P R*, which is percurred in the first moment; the three next triangles may refer the three fathoms *R S*, which are percurred in the second moment; the five following triangles, the five fathoms *S T*, which are pervaded in the third moment: and the seven following, the seven fathoms, which are pervaded in the fourth moment. Now from hence

hence it is manifeſt, that the Aggregate ſpaces carry the ſame proportions, as the Quadrates of Times: when, the Triangle *A D E* (or ſpace *P R.*) is one, as the Quadrate of *A E*, that is of one Time, is one: and the Aggregate *A F G* (or *P S*) is four: as the Quadrate *A G*, of two, is fower: and the Aggregate *A H I* (or *P T*) is nine: as the Quadrate *A I* of three, is nine; and the Aggregate *A K L* (or *P Q.*) is ſixteen, as the Quadrate *A L* of four, is ſixteen.

Thirdly, we may account the Line *D E* for the firſt degree of Velocity acquired in the end of the firſt time; inſomuch, as the firſt time *A E* is not individual, but may be divided into ſo many inſtants, or ſhorter times, as there are points, or particles in the line *A E* (or *A D*) ſo neither is the degree of Velocity individual, or wholly acquired in one inſtant; but from the beginning encreaſeth through the whole firſt time, and may be repræſented by ſo many Lines, as may be drawn parallel to the Line *D E*, betwixt the points of the Lines *A D* and *A E*: ſo that, as thoſe Lines do continually encreaſe from the point *A* to the Line *D E*; ſo likewiſe doth the Velocity continually encreaſe from the beginning of the motion, and being repreſented what it is in the intercepted inſtants of the firſt time, by the intercepted Lines, it may be repreſented what it is in the laſt inſtant of the ſame firſt time, by the Line *D E* drawn betwixt the two laſt points of the Triangle *A D E*. And becauſe the Velocity, thenceforward continuing its Encreaſe, may be again ſignified, by Greater and Greater Lines continently drawn betwixt all the ſucceeding points of the remaining Lines, *D B* and *E C*; hence comes it, that the Line *F G*, doth repreſent the degree of Velocity acquired, in the end of the ſecond moment: the Line *H I.* the Velocity acquired in the end of the third moment; and the Line *K L.* the velocity acquired in the end of the fourth moment. And evident it is from hence, how the velocities reſpond in proportions to the Times; ſince, by reaſon of the Triangles of a common angle, and parallel baſes, it is well known, that as *D E* are to *E A*, ſo *F G* to *G A*: *H I* to *I A*, and *K L* to *L A*. Thus, keeping your eye upon the Figure, and your mind upon the Analogy; you ſhall fully comprehend, that in the firſt moment of Time, the falling ſtone doth acquire one degree of Velocity, and pervades one degree of ſpace; that in the ſecond moment of Time, it acquires another degree of Velocity, which being conjoynd to the former, makes two, and in the mean while three ſpaces are pervaded; that in the third moment, it acquires another degree of Velocity, which conjoyned to the two former makes three, and in the mean while ſeven parts of ſpace are pervaded; and ſo forward. You ſhall fully comprehend alſo, that the Celerities obtain the ſame Ration, as the moments of Time: and that the ſpaces pervaded from the beginning to the end of the motion, have the ſame Ration, as the Quadrates of the moments of Time; which we aſſumed to Demonſtrate, out of *Gaſſendus*. But ſtill it concerns you to remember, that we here diſcourſe of that Motion, which is Equally, or Uniformly Accelerated; or whoſe velocity doth continually and uniformly encreaſe, nor is there any moment of the conſequent time, in which the motion is not more ſwifr, than it was in every antecedent moment, and in which it is not accelerated

according to the ſame Reaſon. For, the want of this Advertiſement in chief, ſeems to have been the unhappy occaſion of that great trouble the Learned Jeſuit *Petrus Cazræus* put *Gaſſendus* to, in his two Epiſtles, *De Proportione, qua Gravia decidentia accelerantur.*

Art. 16. The *Phyſical* Reaſon of that Proportion.

And this kindly conducts us to the *Phyſical* Reaſon of this Proportion, in which the velocity of bodies Deſcending is obſerved to encreaſe. For wholly excluding the ſuppoſition of the Aers aſſiſtance of the Downward motion of a ſtone, by recurring above, and ſo impelling it downward; and admitting the Magnetick Attraction of the Earth to be the ſole Cauſe of its Deſcent; unto both which the conſiderations formerly alleadged ſeem to oblige us: it is familiar for us to conceive, that the Increment of its Celerity, according to the proportion aſſigned, ariſeth from hence. While in the firſt moment, the earth attracts the ſtone, one degree of Celerity is acquired, and one degree of ſpace is pervaded. In the ſecond moment, the attraction of the Earth continuing, another degree of celerity is acquired, and three equal ſpaces are pervaded: one by reaſon of the degree of celerity in the mean while acquired, and two by reaſon of the degree of celerity formerly acquired, and ſtill perſevering, as that which is doubly æquivalent to the new degree in the mean while acquired; becauſe it is Complete and entire from the very beginning of the 2d moment, but the other is only acquiring, or in *fieri*, and ſo not complete till the end of the ſecond moment. Then, according to the ſame Ration, in the third moment another degree of celerity is acquired, and five ſpaces (equal) are pervaded; one by reaſon of the new degree of celerity in the mean while acquired, and fower by reaſon of the two former perſevering, i.e. two in each moment præcedent, or one of a duplicate æquivalency to the new one not yet complete. Then, in the fourth moment another degree of celerity is acquired, and ſeven ſpaces are pervaded; one by reaſon of the freſh degree in the interim acquired, and ſix by reaſon of the three former perſevering, i. e. two in each præcedent moment. And ſo of the reſt through the whole motion, computing the degrees of encreaſing Celerity, by the ration of Quadrate Numbers.

Art. 17. The Reaſon of the *Equal Velocity* of Bodies of very *different weights*, falling from the ſame altitude; inferred from the ſame Theory.

Now, many are the Phyſical Theorems, and of conſiderable importance, which might be genuinely deduced from this excellent and fruitful Phyſicomathematical ſpeculation; and as many the admired Apparences in nature, that offer themſelves to be ſolved by Reaſons more than hinted in the ſame: but, ſuch is the ſtrictneſs of our method, and wearineſs of our Pen, that we can, in the præſent, make no farther advantage of it, than only to infer from thence the moſt probable Reaſon of that ſo famous Phænomenon, *The equal velocity of two ſtones, or bullets, the one of* 100 *pound, the other of only one ounce weight, deſcending from the ſame altitude*; experience conſtantly atteſting, that being dropt down together, or turned off, in the ſame inſtant, from the top of a tower; the Leſſer ſhall arrive at the ground, as ſoon as the Greater. For, this admirable Effect ſeems to have no other Cauſe but this; that the Leſſer body, as it containeth fewer parts, ſo doth it require the Impulſes or ſtrokes of fewer Magnetical rays, by which the attraction is made: and ſuch is the proportion of the two forces, as that each moveable being conſidered with what Reſiſtence you pleaſe, ſtill is the force in the movent equally ſufficient to overcome that reſiſtence, and a few magnetique rays ſuffice to the attraction

attraction of a few parts, as well as many to the attraction of many parts. So that the ſpace being equal, which both are to pervade; it follows, that it muſt be pervaded by both, in equal or the ſame time. Provided always, that the two bodies aſſumed, be of the ſame matter; for, in caſe they be of divers matters, as the one of Wood, the other of Iron or Lead, that may cauſe ſome ſmall Difference in their Velocity. We ſay, ſome ſmall Difference; becauſe, if we take two Globes of different materials and weights, but of the ſame or equal diameters, as (V. G.) one of Lead, the other of Wax: we ſhall be very far from finding, that the Heavier will be carried down more ſwiftly than the Lighter, in a proportion to the exceſs of its Gravity. For, if one be ten times heavier than the other; yet ſhall not the Heavier therefore, both being turned off, in the ſame inſtant, arrive at the ground ten times ſooner than the Lighter: but, at the ſame time as the heavier, arrives at the ground, from the altitude of 10 Fathoms; the lighter ſhall come within a foot of the earth; ſo far ſhort doth the lighter come of being nine fathoms behind the Heavier. And the Cauſe, why the Lighter Globe of Wax, is carried ſo ſwiftly, is the ſame with that, why a bullet of Lead of only an ounce weight, is carried down as ſwiftly as another bullet of 100 pound. And, what though the Globe of Wax be as great in circumference, as the other of Lead, and ſomewhat greater; yet ſeeing ſtill it hath fewer parts to be attracted, it therefore requires fewer magnetical rays to its attraction with equal velocity to the heavier. But, the Cauſe why it is carried ſomwhat, though very little, ſlower than the heavier; is to be derived chiefly from the Aer reſiſting it underneath, the Aer being more copious in proportion to the virtue Attrahent, in reſpect of the greatneſs of its Ambite, or Circumference: and thence is it, that Cork, Pith of Elder, ſtraws, feathers, and the like leſs compact, and ſo more light bodies, fall down much more ſlowly.

Art. 18. Gravity Diſtinguiſh'd into *Simple*, and *Adjectitious*.

From this Experiment, and the Reaſon of it, we have an opportunity of obſerving and eaſily underſtanding the Diſtinction of *Gravity* into *Simple* and *Adjectitious*: the *Former* being that, which is competent to a body though unmoved, and whoſe quantity may be exactly determined by the balance ſuſpending the body in the aer; the *Latter* being proper only to a body moved, and vaniſheth as ſoon as the body attaineth quiet, and whoſe meaſure is to be explored both from the quantity of the ſimple gravity which the body bears during its quiet, and the Altitude from which it falls. Thus, aſſuming two Bullets, the one of an ounce, the other of 100 pound, Simple Gravity, according to the Scales; the Adjectitious Gravity of the Leſſer bullet, acquired by the increment of its velocity during its deſcent, muſt be leſs proportionably to its ſimple gravity, than the Adjectitious gravity of the Greater bullet, acquired by the increment of its Velocity during its Deſcent, in the ſame time, and from the ſame altitude: becauſe, the ſpace and time of the deſcent of both being equal, the proportion of the acquired gravity of each muſt be reſpondent to the proportion of the ſimple gravity of each. So that if in the end of the fall of the Leſſer bullet of an ounce weight, the Adjectitious Gravity of it ſhall amount to 10 ounces: the Adjectitious gravity of the Greater of 100 pound weight, ſhall, in the end of its fall, amount to a thouſand pound; nor can the Acquired Gravity of the Leſſer ever equal that of the Greater, unleſs it fall from a far greater Altitude.

Here,

Art. 19. The *Rate* of that superlative velocity, with which a Bullet would be carried, in case it should fall from the *Moon*, *Sun*, or region of the *Fixed stars*, to the Earth: and from each of those vast heights, to the *Centre* of the Earth.

Here, perhaps, you'l Demand our opinion, concerning that admirable because superlative Velocity, which *Galileo* and other *Mathematicians* conceive that a bullet would acquire in case it should fall to the Earth from those vast (we might have said Immense) heights of the *Moon*, *Sun*, and region of the *Fixed* starrs. Of this, therefore, we say in short; (1) That, in this case, Mathematicians are wont to suppose, that there are the same Causes of Gravity and Velocity in those sublime places, as are observed here with us below, or neer the surface of the Earth: and if they be not, certainly our Description and Computation must be altogether vain and fruitless. For, if the Cause of Gravity, and consequently of the Velocity be the Attraction made by the magnetique rays transmitted from the Earth; forasmuch as those magnetique rays must become more Rare, and fewer of them arrive at a body, by how much farther it is removed from the Earth: though, perchance, a bullet might be attracted down from the region of the Moon (and if so, the motion of the bullet would be very slow, for a good while, in respect of the very few magnetique rays, that could arrive to that great height) yet from that far greater height of the region of the Fixt stars, a bullet could not be attracted at all, it being impossible that any magnetique ray should be transmitted so far as half way thither. (2) But, supposing that the magnetique Virtue of the Earth did extend thither; and that a bullet, from whence soever falling, should begin its motion with that speed, and proceed according to the same degrees of Acceleration, which we observe in a stone, or bullet falling from a very high tower: then must it of necessity acquire that incredible Velocity, which our Mathematicians describe. To Particular; conceding the Distances or Intervals betwixt the Earth and each of those Cælestial Orbs, which our modern and best Astronomers generally assign; a bullet would fall from the body, or rather the Limbus of the Moon, to the Earth, in two hours and an half; from the Limbus of the Sun, in eleven hours and a quarter: from the region of the Fixt stars, in 39 hours and a quarter. And so, if we imagine the Earth to be perforated to the Centre, since a bullet would fall from the superfice thereof down to the Centre, in 20 minutes, or the third part of an hour: the same bullet coming from the moon, would pervade the same space from the superfice of the Earth to the Centre of it, in one minute and twenty seconds, or the third part of a minute: coming from the Sun, it would pervade the same semidiametral space of the Earth, in seventeen seconds: and coming from the region of the Fixt stars, it would percur the same semidiametral space of the Earth, in five seconds. So incredibly great would be the Velocity of a bullet falling from such vast Altitudes. And this we think sufficient, concerning the *Downward* motion of Bodies, accounted Heavy.

SECT.

SECT. III.

THe Remnant of our præſent Province conſiſts only in the conſideration of the *Upward* motion of Heavy Bodies PROJECTED: concerning which the principal Enquiries among Philoſophers are (1) *VVhat and whence is that Force, or Virtue motive, whereby bodies projected are carried on, after they are ſeparated from the Projicient?* (2) *What are the Laws of their motion. Direct, and Reflex?*

Art. 1. *What*, and *whence* is that *Force*, or Virtue *Motive*, whereby Bodies Projected are carried on after their Diſmiſſion from the Projicient.

Concerning the FIRST, therefore, we obſerve, that *Ariſtotle* (*in* 8. *phyſic.cap.ult.*) and moſt of his *Sectators* confidently affirm, that a ſtone thrown out of a ſling, an arrow ſhot from a bow, a bullet diſcharged from a Gun, &c. is moved only by the *Aer*, from the time of its ſeparation from the ſling, bow, or Gun: and the manner of that motive activity of the Aer upon the thing projected, They thus explicate. The Aer (ſay they) which is firſt moved by the Projicient, together with the moveable, doth, at the ſame time, both propel the moveable, and impel the Aer immediately beyond it, which being likewiſe moved, doth in the ſame manner propel the moveable, and impel the aer immediately beyond it; and that aer being thus moved, doth again impel both the moveable and the aer next beyond it: and ſo conſequently the next aer impels both the moveable and the next aer beyond it, until the propulſion and promotion being gradually debilitated, and at length wholly overcome, partly by the Gravity of the thing moved, partly by the Reſiſtence of the occurring Aer, the motion wholly ceaſeth, and the thing projected attaineth quiet.

And that *Others* contend, that the Body Projected is carryed forward by a *Force* (as They call it) *Impreſt*; which they account to be a Quality ſo communicated unto the body projected, from the Projicient, as that not being indelible, it muſt gradually decay in the progreſs thereof, and at length wholly periſh, whereupon the motion alſo muſt by degrees remit its violence, and at length abſolutely vaniſh, and the thing projected again recover its native quiet. But, leſt we trifle away our præcious moments, in confuting each of theſe weak Opinions, againſt which the Reaſon of every man is ready to object many great abſurdities, eſpecially ſuch as the præcedent theory will ſoon advertiſe him of: let us præſently recur to the more ſolid ſpeculations of our maſter *Gaſſendus* in his Epiſtles (*de motu impreſſo a motore tranſlato*) and præſenting you the ſummary thereof, without further delay ſatisfie your Curioſity, and our own Debt of aſſiſting it.

Firſt we are to determine, *that nothing, remaining it ſelf unmoved, can move another.* For, ſince our Diſcourſe concerns not the Firſt Cauſe of all motion, *God*, whoſe Power is infinite, who is in all places, who can, only by the force of his Will, create, move, and deſtroy all things; manifeſt it is, that nothing *Finite*, eſpecially *Corporeal* (and ſuch only hath

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an intereſt in our præſent conſideration) can move another thing, unleſs it ſelf be alſo moved, at the ſame time: as *Plato* well obſerved in his ſaying, *Neque eſt Difficile modo, ſed etiam plane impoſsibile, ut quidpiam motum imprimere, ſine quapiam ſui commotione, valeat: (in Timæo.)* And the Reaſon is this; whatever doth move, doth act; and *e converſo*, whatever doth act, doth move; Action and Paſſion (as Ariſtotle, 3.phyſic.3) being the ſame with motion. Again, the movent and Moveable ought to be together, or to touch each other, becauſe, whether the movent impel, attract, carry, or rowle the moveable: neceſſary it is, that ſtill it ſhould impreſs ſome certain Force upon it: and force it can impreſs none thereupon, unleſs by touching it. And though it doth touch it, yet if it diſcharge no force of motion upon it, i. e. remain unmoved it ſelf: there ſhall be only a meer Contact reciprocal, but no motion, and as the one, ſo ſhall the other remain unmoved. Therefore, that the one may move the other: it ought to have that vigour or motion firſt in it ſelf, which it doth impreſs upon the other: ſince if it have none, it can give none. Even ſenſe demonſtrates, that by how much more vehement motion the movent it ſelf is in, at the inſtant it toucheth the moveable, by ſo much the farther doth it always propel the ſame: and thence our Reaſon may neceſſarily infer, that the movent muſt it ſelf be in ſome ſmall motion, in the ſame inſtant it gives a ſmall motion to another. Moreover, though *Ariſtotle (in 8.Phyſic.cap.5.)* ſubtly Diſtinguiſheth three Things in motion, viz. the *Movens ut quod*, as (V. G.) a man, the *Movens ut quo*, as a ſtaff: and the *Mobile*, as a ſtone: and thereupon magiſterially teacheth, that the ſtone is moved, and doth not move; that the ſtaff is moved, and doth move: that the man doth move, and is not moved: yet is it not evident, how far ſhort He comes, of thereby Demonſtrating the Immobility of the Firſt Movent, to which He prætended. For, whereas He urgeth, that otherwiſe we muſt proceed to Infinity; that binds not at all: becauſe the *movens ut quod*, the man is moved by Himſelf: and ſenſe declares, that the man muſt move his Arm, or Hand together with the ſtaff, which if you ſuppoſe not to be the *movens ut quo*, (the ſtone being not moved thereby) but the *mobile* it ſelf: is not the movent it ſelf alſo moved? Suppoſe alſo, that the mans Arme, or Hand is the *movens ut quo*, nay if you pleaſe, that his whole Body, or the Muſcles, or Nerves, or Spirits, are the *movens ut quo*, and deriving the motion from his very Soul, ſuppoſe that to be the *movens ut quod*: yet truely can you not conceive, that the Soul, it ſelf remaining Immote, doth move the Arm, or Hand. Nor is the Soul it ſelf then moved onely by Accident (as when a marriner is carried by the motion of his ſhip) but alſo *per ſe*, as when the mariner moves himſelf, that he may move the Oar, that it may move the ſhip, in which himſelf is carried. For, as a ſhip, in a calm ſea, would not be moved it ſelf, nor the mariner be moved with it, by Accident: in caſe the mariner himſelf wanted motion, whereby to impel his ſhip: ſo neither would the body be moved, nor the Soul be moved therewith by Accident, unleſs the ſoul be firſt agitated within, with a motion whereby the body is moved. Conclude, therefore that nothing can be projected, but the Projicient muſt not only Touch it, either immediately, or mediately by ſome Inſtrument; but alſo Propel it with the ſame motion, wherewith it ſelf is, in the ſame inſtant, moved.

It is moreover neceſſary, that the movent be moved, not only in a point, or

or ſo far as that point of ſpace, in which it firſt toucheth the moveable: but alſo that a while cohæring unto the moveable, it be *moved along with it*: ſo as we may well conceive them to be made, by that Cohæſion, as it were one and the ſame body, or one entire moveable, pro tempore; and conſequently, that the motion of both the movent and moveable is one intire motion. For, what motion is in the moveable, ſo long as it remains conjoyned to the movent, is in a manner a certain Tyrocinium, in which the moveable is as it were taught to progreſs foreward in that way, which the movent hath begun, upward, downward, tranſverſe, oblique, circular, and that either ſlowly, or ſwiftly, and according as the movent ſhall guide and direct it, before its manumiſſion or diſmiſſion.

Thus, when a man throws a ſtone with his hand, you may plainly perceive, how the motion thereof begins together with that of his hand: and after it is diſcharged from his hand, you cannot ſay, that a new motion is impreſſed upon the ſtone, but only that the ſame motion begun in the hand is continued. And, therefore, it ſeems alſo very unneceſſary to require the impreſſion of any new and diſtinct Force upon the ſtone projected, by the projicient, which ſhould be the Cauſe of its motion after its Diſmiſſion: ſeeing nothing elſe is impreſſed, but the very motion to be continued through a certain ſpace; ſo that we are not to enquire, what motive Virtue that is, which makes the Perſevering motion, but what hath made the motion, that is to perſever. In the moveable, certainly, there is none but a Paſſive Force to motion; nor can the Active Force be required in any thing but the movent: and ſhould we, with the Vulgar, ſay, that there is an Impreſt Force remaining, for ſome time, in the thing moved, or projected; we could thereby underſtand no other than the Impetus, or motion it ſelf.

Art. 2. The *Manner* of the Impreſſion of that Force.

Here might we opportunely inſiſt upon this, that motion is impreſſed upon a thing moved, only in reſpect, that the thing moved hath leſs force of Reſiſtence, than the movent hath of Impulſion: ſo that the movent, forcing it ſelf into the place of the moveable; compels it to recede, or give way, and go into another place. But it is more material for us to obſerve; that when a thing projected is impelled, it is firſt touched by the projicient only in thoſe parts, which are in its ſuperfice or outſide and that thoſe outward parts, being preſſed by the impulſe, do drive inward or preſs upon the parts next to them; and thoſe again impel the parts next to them, and thoſe again the next to them; till the impulſe be by ſucceſſion propagated quite through the body of the thing projected, to the ſuperficial parts in the oppoſite ſide, and then begins the motion of the whole, the parts reciprocally cohæring: as hath been formerly explained, in the example of a long pole, or beam of wood. Which being percuſſed, but with a very gentle or ſoftly ſtroke, that one end hath all its parts ſo commoved ſucceſſively, as that the ſtroke may be plainly perceived by a man, that lays his ear cloſe to the other end: which could not be if the impulſe were not propagated from parts to parts ſucceſſively, through the whole ſubſtance of the beam. To which it is requiſite, that we ſuperad this obſervable alſo; that by reaſon of the force made by Contact, and that ſhort Cohæſion of the moveable to the movent, there is created a certain *Tenſion*, or ſtreſs of all the parts of it, towards the oppoſite region: and of that by that means, all the parts of the thing

projected, are disposed or conformed as it were into certain *Fibers*, or direct *Files*; of all which the most strong and powerful is that, which being trajected through the Centre of Gravity in the thing projected, becomes as it were the *Axis* to all the circumstant ones. Our eys ascertain, that unless the Centre of Gravity be in the middle of the thing projected, or directly obverted to the mark, at which the thing is thrown; the thing instantly turns it self about, and that part, wherein the Centre of Gravity is, always goes foremost, and as it were carries the rest of the parts, as that which is the most Direct and most Tense of all the Fibres. And this cannot be effected, but with some (more or less) *Deflection* from the mark, at which the force, according to the Centre and Axis of Gravity, was directed; forasmuch as the Centre of Gravity, wherein many Fibres concur, makes some Resistence, and detorting the Fibres, inflecteth them another way, and so a new Axis is made *pro tempore*, according to which the Direction of all the parts in their motion afterward is determined. Hence is it, that, if you would hit a mark, either with a sling, or stone-bow, you must choose a stone, or bullet of an uniform matter and composition: or, at least, turn the heavier part of the body to be thrown, forward; because otherwise, it will Deflect more or less, to one side or other according to the position and inclination of its Centre of Gravity. Moreover, whether soever the thing projected doth tend, all the Fibers constantly follow the Direction of the Axis, or are made parallels thereunto; so that as often as the Centre is changed, so often doth the Axis, so often do all the Fibres change their position, and follow the Centre. Which we insert chiefly in respect of the motion of Convolution, or Turning of a thing projected immediately after its Dismission; and of the Curvity of that Line, which is thereby described, whether ascending, or descending. But these are onely Transient Touches, or Hints; that we might easily intimate, why a motion once impreſt, is continued rather this way, than that: and why Feathers, Sponges, and the like Light and Porous bodies, are incapable of having quick and vehement motions impreſt upon them; because they consist of interrupted Fibres, and such as are not Dirigible with the Centre of Gravity.

Art. 3. That all Motion, in a free or *Empty* space, must be *Uniform*, and *Perpetual*: and that the chief Cause of the *Inequality* and *Brevity* of the motion of things projected through the *Atmosphere*, is the magnetique Attraction of the Earth.

Here we ask leave, once more to have recourse to that useful supposition of a stone situate in the immensity of the Imaginary spaces. We lately said, as you may remember, that if a stone placed in the empty Extramundane spaces, should be impelled any way, the motion thereof would be continued the same way, and that uniformly or equally, and with tardity or celerity proportionate to the smartness or gentleness of the Impulse, and perpetually in the same line; because in those empty spaces it could meet with no cause, which by Diversion might either accelerate, or retard its motion. Nor ought it to be Objected, that *nothing Violent can be Perpetual*; because, in this case, there could be no Repugnancy or Resistence, but a pure Indifferency in the stone to all regions, there being no Centre, in relation whereunto it may be conceived to be Heavy or Light. And, therefore, the condition of the stone would be the very same, as to Uniformity and Perpetuity of motion, with that of the Cælestial Orbs; which being obnoxious to no Retardation, or Acceleration, but free from all Repugnancy internal, and Resistence External, constantly and indefinently maintain that Circular motion, which was, in the first moment of their Creation, impreſt uopon them, by the Will of the Creator

tor; and that toward one part, rather than any other. Let us now farther consider; seeing that if upon some large horizontal plane you should place a smooth Globe, and then gently impel it; you would observe it to be moved therupon equally and indefinently, till it came to the end thereof: why may you not lawfully conjecture, that if the Terrestrial Globe were of a superfice exquisitely polite, or smooth as the finest Venice Glass; and another small Globe as polite were placed in any part of its superfice, and but gently impelled any way, it would be moved with constant Uniformity quite round the Earth, according to the line of its first direction; and having rowled once round the Earth, it would, without intermission again begin, or rather continue another Circuit, and so maintain a perpetual Circulation upon the surface of the Earth? Especially, since there is no Difficulty to discourage that conjecture; forasmuch as look how many parts of the small Globe, during the motion thereof, tend toward the Centre of the Earth, just so many are, at the same time, elevated from it: so that a full Compensation being made in all points of the motion, the same cannot but perpetually continue, and in the same equal tenour, there being no Declivity, whereby it should be Accelerated, no Acclivity, wherby it should be Retarded, no Cavity, whereby after many accurses and recurses, or reciprocations, it should be brought at length to acquiesce. Moreover, in order to our grand scope, let us suppose, that the space, through which a stone should be Projected, were absolute Inane, or such as the Imaginary spaces; and then we must acknowledge, that it would be carried in a direct and invariate line, through the same space, and with an Uniforme and Perpetual motion, until it should meet with some other space, full of magnetique rayes, Aer, or some other resisting substance. But, here with us, in the Atmosphere, because no space is Inane (sensibly) but replete as well with Aer, as with millions of magnetique rayes transmitted from the Earth; and so a stone Projected must encounter them in every point of space through which it moves: therefore is it, that it cannot be moved either in a direct Line, or equally, or long. For, since multitudes of magnetique Rayes must necessarily invade and attach it, as soon as it is discharged from the Projicient; though at first setting forth it break through them, and so is scarce at all Deflected: yet because more and more magnetique rayes freshly lay hold of it in every part of space, renew the Attraction, and so more and more infringe and weaken the force of its motion; hence comes it, that in the progress it doth by little and little Deflect from the Line of Direction, moves slower and slower, and at length sinking down to the Earth, thereon attains its quiet. Hereupon, when men shall Demand, *what is that Cause, which weakens and at last quite destroys the Virtue Impressed upon a thing Projected*; rightly understanding, by the Virtue Impreſt, the motion begun by the Projicient, and continued by the Projectum: the Answer is manifest; *viz.* That it is the *Attraction of the Earth*, which first opposeth, after gradually refracteth, and in fine wholly overcometh the motion impreſt, and so determineth the Projectum to Quiet. Hence also may we learn, that *All motion once impressed, is of it self Indelible*, and cannot be Diminished, or Determined, but by some External Cause, that is of power to repress it.

Art. 4. That, in the Atmosphere, no body can be projected in a *Direct* line; unless perpendicularly Upward, or Downward: and why.

This considered, you may please to observe, that through the Atmosphere, or spaces circumvironing the Terrestrial Globe, being so possessed by the Aer and swarms of Magnetique Rayes, *no body can be projected in an absolute Direct: or perfectly streight Line*, unless perpendicularly upward or downward. For, if the projection be made either obliquely, or parallel to the Horizon; the projectum suddainly begins to Deflect from the mark at which it was aimed, and so describes not a streight, but crooked line. Not that the Deflection or Curvity is sensible, at a small distance, especially if the motion be vehement, such as that of an Arrow shot from a Bowe, or Bullet discharged from a Gun: but, that in every point of space, and time, the thing Projected is attracted somewhat Downward; and there is the same Reason for its Deflection in the first, as there is for its Deflection in the second, third, fourth, or any following point of space, and instant of time, though the greater opposition of the Force impreſt makes that Deflection less at the first. Nor ought it to incline us to the contrary, that Archers and Gunners frequently hit the mark, at which they levelled, to some certain distance: because, that Distance is commonly such, as that the Deflection therein is not sensible, though it be sometimes an hairs-breadth, two, three, or four, sometimes an inch below the mark.

Art. 5. That the Motion of a stone projected upwards obliquely, is Composed of an *Horizontal* and *Perpendicular* together.

Further you may observe, that when a stone is projected, or a bullet shot upward, yet not perpendicularly, but obliquely; the motion thereof is to be considered, not as simply perpendicular, or simply Horizontal, but as *mixed*, or *composed of an Horizontal and Perpendicular together*: of a Perpendicular, forasmuch as the Altitude thereof may be measured by a Perpendicular line; of an Horizontal, forasmuch as it is made according to the Horizon, and the Latitude thereof may be taken by the plane of the Horizon. But, because by how much the more it hath of the perpendicular, so much the less it hath of the Horizontal; so that the Altitude of it may amount to fifty feet, and the Latitude not exceed one foot: therefore is it manifest, that the crooked Line described by this Compass motion, cannot be Circular; and *Galilæo* (*Dialog.* 4.) hath demonstrated that the Line is *Parabolical*, or such as Geometricians describe in the ambite of a Cone, when they so intersect it obliquely from one side at the base, that the motion of the intersection is made parallel to the other side left whole, for the Area of each resegment is the Geometricians Parabola: and the crooked ambite of the Area, is a Parabolical Line, and frequently taken for the Parabola it self. We remember also, how *Galilæo*, upon consequence, and among other remarkables doth observe; that of all Projections, made by the same force, the *Longest*, and in that respect the most *Efficacious*, is that, which is made to an *half-right* Angle, or by aiming at the *forty fifth* degree of Altitude; in respect of the more prolix Parabola which is described by the Projectum, aimed at that altitude: since at all other altitudes the Parabola must be shorter; the superior Altitudes being less, and the inferior more open than is requisite.

Now

Now this Compoſition of a Perpendicular and Horizontal motion may be moſt conveniently Demonſtrated unto you, thus. Being in a ſhip, under ſayl, if you hold a Ball in your hand; the motion of the ball will be onely Horizontal, *viz.* That, whereby the ſhip doth carry you, your hand, and the ball in it. If the ſhip ſtand ſtill, and you throw the ball directly upward; the motion of the ball will be onely Perpendicular: but if the ſhip be moved, at the ſame inſtant you throw the ball upward; then will the motion thereof be Compound, partly Perpendicular, partly Horizontal. For, the ball ſhall be carried obliquely, and deſcribe a Parabolical line, in which it aſcends and again falls down again; and in the mean time, it ſhall be promoved Horizontally. The Perpendicular alone, your ſelf may diſcern with your own eye: becauſe, the horizontal is common both to the ball and your eye, and when as well the ball, as your eye is promoved, therefore doth it always appear imminent over your eye, and in the ſame perpendicular: but, for the Horizontal, He onely can deprehend it, who ſtands ſtill on the ſhoare, or another ſhip not carryed on at the ſame rate, as that wherein you are.

Art. 6. Demonſtration of that *Compoſition.*

Herein there occur Two things, not unworthy our admiration. The *One* is, that *though there be two divers Forces or motions impreſſed upon the Ball, at the ſame time: the one from the Vibration of your Arm, the other from the horizontal Tranſlation of the ſhip: yet doth neither deſtroy the other, but each attains its proper ſcope as fully, as if they were impreſſed apart.* For, the Ball aſcends as high, when the ſhip is moved forward, as when it ſtands ſtill: and whether it deſcribe a Direct, or a ſemiparabolical: and again, it is as much promoved Horizontally, when you divert it upward by projection, as when you hold it ſtill in your hand and ſo it be carried onely by the motion of the ſhip: and conſequently whether the motion thereof deſcribe a Direct line, or a whole Parabola. Onely this you are to note: that a greater Force is required to the projection of a Ball from the foot to the top of the Maſt, when the ſhip moves forward, than when it lies at anchor: becauſe that ſemiparabolical line, which the Ball muſt deſcribe in the former caſe, is ſhorter than that perpendicular one, which it muſt deſcribe in the latter: and however the vibration or ſwing of your arme may ſeem to you to be equal in both caſes, yet is that vibration or force, whereby the ball is carried upward to the top of the Maſt, when the ſhip is in motion, really greater than that, whereby the ſame ball is carried to the ſame height, when the ſhip lies quiet: becauſe, in the former caſe, there is ſuperadded to the force of your arme, the force which is impreſſed both upon you and your arme (without your apprehenſion) by the motion of the ſhip. This you ſhall plainly perceive, if you onely drop down a ball from the top of the Maſt, without any ſwing or motion of your arme at all. For, ſeeing that the ball doth always fall at the foot of the maſt, in the ſame diſtance from it, as it was in the inſtant of its dimiſſion from the top; whether the ſhip be moved, or quiet: neceſſary it is, that ſome force be impreſt upon the

Art. 7. That of the two different *Forces*, impreſſed upon a ball, thrown upward from the hand of a man ſtanding in a ſhip, that is under ſayl; the one doth not deſtroy the other: but each attains its proper ſcope.

the ball by the motion of the ſhip, or the the ſame motion, whereby both the Maſt it ſelf, and your hand are affected, at the inſtant of its dimiſſion; ſince it muſt deſcribe a ſemiparabolical line, longer than that Direct one, which it would deſcribe, if it fell down the ſhip being quiet. And hence comes it, that if you project a ball from the Poop to the Fore Caſtle of a ſhip, under ſayl, and back again from the Fore-Caſtle to the Poop; you ſhall impreſs a greater force upon it, in throwing it from the Poop to the Fore-Caſtle, than back again from the Fore-Caſtle to the Poop: becauſe, in the former caſe, the force or ſeconding impulſe of the ſhip muſt be ſuperadded to the force of your arme in projection, and ſo make it the ſtronger; and, in the latter caſe, the contrary force of the ſhip doth as much detract from the force of your arme, and ſo make it the weaker. And though the ball be carried over equal ſpaces of the Deck of the ſhip, in both caſes: yet ſhall it not be carried through equal ſpaces in the Aer.

Art. 8. That the ſpace of time, in which the Ball is *Aſcending* from the *Foot* to the Top of the Maſt; is *equal* to that, in which it is again *Deſcending* from the top to the foot.

Hence may it be Demonſtrated, *that the ſpace of Time which the ball is Aſcending from the foot to the top of the Maſt, is Equal to that in which it is Deſcending again from the top to the foot.* For, were it not ſo, when the ball is projected in a line perpendicular and parallel to the Maſt, the ball would not aſcend and deſcend always at the ſame diſtance from the Maſt, but would either deſert it, or be deſerted by it, the ſhip being in motion. Whence it follows alſo, that in what proportion the velocity of the ball Aſcending doth decreaſe; in the ſame proportion doth the velocity of the ball again Deſcending encreaſe: ſo that the motion of the ball muſt be of equal velocity, when it is removed from the plane of the ſhip, one fathom aſcending, or deſcending, and likewiſe at the altitude of one foot, aſcending or deſcending. Again, foraſmuch as the force of your arme, projecting the ball, is ſtill equal; but the force ſuperadded thereunto by the motion of the ſhip, may be more or leſs vehement, according as the ſhip is carried with greater or leſs ſpeed: thence it follows, that the Parabolical lines deſcribed by the ball, are reſpectively Greater or Leſs, and the motions of it through the Aer more or leſs ſwift. But, yet all are performed in Equal Time; becauſe the times of them all are equal to the ſame time, which is due to the ſimple Aſſent and Deſcent, and with the ſame proportion of parts.

Art. 9. That, though the *Perpendicular* motion of a ſtone thrown obliquely upward, be *Unequal*, both in its aſcent and deſcent: yet is the *Horizontal* of *Equal* Velocity in all parts of ſpace.

The *Other*, which deſerves our admiration, is this; that notwithſtanding, of the twofold motion compoſing the Oblique one, that which is Perpendicular, is Unequal, the Velocity thereof being as well diminiſhed in the aſſent, as augmented in the deſcent, ſo that; in equal moments of time, leſs ſpaces are pervaded in the aſſent, and greater in the deſcent: yet *is that motion, which is Horizontal, plainly Equal in all its parts, or of equal velocity throughout; ſo that equal ſpaces of the Horizon are pervaded in equal times.* The truth of this is conſtant from hence; that if (the ſhip being equally moved on, and the ball being projected in a line parallel to the Maſt) the foot of the Maſt ſhall pervade twenty paces,

paces, or an hundred foot of horizontal ſpace: the ball ſhall be horizontally (i. e. toward that region, to which the ſhip tends) promoved, not more ſwiftly or ſlowly in one pace or foot, than in another, but equally in all: for, otherwiſe, it could not be always imminent over the ſame part of the ſhip neer the Maſt: nor therefore conſiſt in the ſame line, or diſtance from the Maſt: which yet it conſtantly obſerves. But this eaſily deceives, that at the end of the balls aſcent, or beginning of its deſcent, the motion is ſloweſt: but then are we to obſerve, that the Devexity, or Conformity of it to the Horizon is the Greater, as when it comes lower, where the motion is more rapid, the Devexity is leſs, and its conformity to the Perpendicular greater: ſo that the whole *Inæquability* doth conſiſt in the Aſſent and Deſcent, or *Perpendicular* motion of the ball: while in the mean time there is a perfect *Æquability* in its *Horizontal* advance, or promotion. From hence we collect: that ſince a thing Projected is moved unequally, inſomuch as it tends upward or downward: and not as it progreſſeth parallel to the Horizon, or Ambite of the Earth: therefore is it, that *the upward and downward motions are both to be accounted Violent: but the Horizontal, or Circular, Natural*: Equality, or Uniformity being the inſeparable Character of Natural, and Inequality of Violent motion.

Art. 10. The Reaſon and Manner of the *Reflexion* or *Rebounding* motion of Bodies, diverted from the line of their direction by others encountring them.

Thus far have we treated of that Returning or Reflex motion of Bodies; whereby, being violently projected upward, they revert or fall down again, by reaſon of the magnetique Attraction of the Earth: and it now remains onely, that we conſider the Reaſons of that other ſpecies of motion *Reflex* or *Rebounding*, whereby Bodies, being alſo violently moved or projected any way, are impeded in their courſe and Diverted from the line of their Direction, by other bodies encountring them. Concerning this Theorem, therefore, be pleaſed to know, that among all Reflexions, by way of Rebound or Reſilition, that is the *Chiefeſt*, when a body projected, and impinged againſt another body, is returned from thence *directly*, or in the ſame line toward the place, from whence it was projected: which always happens, when the Projection is made to right Angles, or in regular line, ſuch as that in which a Heavy body deſcends upon an horizontal plane. And all other Reflections are in dignity inferior thereunto, as ſuch whereby the thing projected doth not rebound in a direct line toward the ſame point from whence it was projected, but to ſome other region by other lines: according as it is projected in lines more or leſs oblique. Becauſe, with what inclination a body falls upon a plane, with the very ſame inclination doth it rebound from the plane (eſpecially a Globe, and ſuch as is of an uniform matter, and conſequently hath the Centre of magnitude and that of Gravity coincident in the ſame point) ſo that by how much the more oblique the projection is, and how much the leſs is the Angle made of its line with the line of the plane, (called the Angle of *Incidence*) ſo much the more oblique is the reflexion made, and ſo much the leſs the Angle made of its line, with the line of the plane continued (called the Angle of *Reflexion*)

flexion) and that so long, as till the line of projection shall become parallel to the plane, and so, no body occurring to or encountring the projectum, no reflexion at all be made.

Art. 11. That the *Emersion* of a weight appensed to a string, from the perpendicular, to which it had reduced it self, in Vibration; is a Reflexion *Median* betwixt *No* Reflexion at all, and the *Least* Reflexion assignable; and the *Rule* of all other Reflexion whatever.

Know moreover, that betwixt *No* Reflexion at all, and the *Least* Reflexion that is possible, there may be assigned as it were a certain *Medium*; and that is the *Emersion* or Rising up again of a weight appensed to a thread or Lutestring, when performing a vibration or swing from one side to the other, it ascends from the perpendicular Line, to which by descending it had reduced it self. For, in that case, no reflecting body doth occur, a simple Arch is described; and yet there is as a certain Procidence or falling down to the lowest point of the Arch, so also a certain Resilition or rising up again from the lowest point of the Arch, toward the contrary side. Again, having conceived a direct line touching the lowest point of the Arch, so as that the weight suspended by a string, may, in its vibration, glance upon it with its lowest extreme, and onely in a point touch the horizontal line; you shall have on each side an Angle made from the Arch and the line touching it, which is therefore called the Angle of Contingence: and because Geometricians demonstrate, that the Angle of Contingence, which truly differs from a right line, is less than any Rectilinear Angle, however acute; therefore may each of those Angles be said to be Median betwixt the right line, and the Angle either of Incidence, or of Reflexion, how small soever it be; and consequently, the Emersion of the weight in Vibration may as justly be said to be Median betwixt the smallest Reflexion and none at all. However, this Emersion seems to be the Rule of all Reflection whatever; for, as in the *Vibration* of a weight appensed to a string, and describing a simple Arch, the Angle of its *Emersion* is always equal to the Angle of its *Procidence*: so in *Projection* describing an Angular line, the Angle of *Reflection* is always (*quantum ex se est*) equal to the Angle of *Incidence*. We say, *quantum ex se est*; for otherwise, whether it be sensible, or not, because so long as the Projectum is transferred, it is always somewhat depressed toward the earth, for the reason formerly alleadged; thence comes it, that the Reflexion can neither be so strong or smart as the Incidence, nor make as great an angle, nor arise to as great an altitude. Which we insinuate, that we might not insist upon this advertisement; that the Æquality of the Angle of the Reflexion to that of the Incidence, may be so much the less, by how much the less the projected body comes to a spherical figure, or doth consist of matter the less uniform.

Art. 12. The Reason of the *Æquality* of the Angles of *Incidence* and *Reflexion*.

For, to attain to that Æquality of the Angles of Incidence and Reflexion, necessary it is, that the body projected be exactly spherical, and of Uniform matter, and so having the Centre of Gravity, and the Centre of magnitude coincident in one and the same point; as we have formerly intimated: it being as well against Reason, as Experience, that bodies wanting those conditions should arise to that æquality which that we may the better understand, let us consider, that as in a Globe, or Ball Falling down, we regard onely that Gravity, which it acquires in its descent, from the magnetique

netique Attraction of the Earth: ſo in a Globe, or Ball Projected, we are to regard onely that Impetus or Force, which being impreſt upon it by the Projicient, ſupplies the place of Gravity, and in reſpect whereof the Centre of its Gravity may be conceived to be one with that of its magnitude. Let a Ball, therefore, be projected Directly or to right Angles, upon a plane; and, becauſe, in that caſe, that Fibre muſt be the Axis of its Gravity, whoſe extreme going foremoſt is impinged againſt the plane: thence is it manifeſt, that the Repreſſion muſt be made, in a direct line, along that Axis; the parallel Fibres in equal number on each part invironing that Axis, and ſo not ſwaying or diverting the ball more to one part than to another, by reaſon of any the leaſt diſproportion of quantity on either ſide. Then, let the ſame Ball be projected Obliquely againſt the ſame plane; and becauſe, in this caſe, not that middle Fibre, which conſtituteth the Axis of Gravity, but ſome one or other of the Fibres circumſtant about it, muſt with one of its exrreams ſtrike againſt the plane: therefore is it neceſſary, that that ſame Fibre be repreſſed by that impulſe, and by that repreſſion compelled to give backward toward its contrary extream, and thereby in ſome meaſure to oppoſe the motion begun, which it wholly overcome, and ſo the ball would rebound from the plane, the ſame way it came, if the Fibres on that ſide the Axis of Gravity, which is neereſt to the plane, were equal in number to that are on the farther, or contrary ſide of it: but, becauſe thoſe Fibres, that are on the farther ſide, or on the part of the Centre and Axis, are far more in number, and ſo there is a greater quantity of matter, and conſequently a greater force impreſt, than on the ſide neerer to the plane; therefore doth the begun motion perſever, as prævailing upon the repreſſion and renitency of the Fibre impinged againſt the plane, and ſince it cannot be continued in a direct line, becauſe of the impediment ariſeing from the parts cohærent, it is continued by that way it can, i. e. by the open and free obliquity of the plane. But, this, of neceſſity, muſt be done with ſome certain Evolution of the Ball, and with the contact of the Fibres poſited in order both toward the Axis and beyond it; and while this is in doing, every Fibre ſtrives to give back, but, becauſe the farther part doth yet prævail over the neerer, therefore doth the neerer part ſtill follow the ſway, and conform to the inclination and conduct of the farther, and all the toucht Fibres change their ſituation, nor are they any longer capable of returning by the ſame way they came, becauſe they no longer reſpect that part from whence they came. We ſay, with the Contact of the plane by the Fibres poſited toward the Axis and beyond it; becauſe, ſince in that Evolution or Turn of the Ball, the extream of the Axis toucheth the plane, yet nevertheleſs no Reſilition, or Rebound is therefore cauſed, in that inſtant; and if there were a reſilition, at that time, it would be to a perpendicular, as well the Axis, as all the circumſtant Fibres being erected perpendicularly upon the face of the plane: but the Reſilition there muſt be beyond it, becauſe the force of the farther part of the Fibres doth yet prævail over that of the neerer. For, the Force of

the farther part doth yet continue direct and intire; but, that of the neerer is reflected, and by the repression somewhat debilitated: and therefore, the Resilition cannot be made, until so much of Repression and Debilitation be made in the further part, as was made at first in the neerer. And that must of necessity be done, so soon as ever the plane is touched by some one Fibre, which is distant from the Axis as much beyond, as that Fibre, which first touched the plane, is distant from the Axis on this side: for, then do the two forces become equal, and so one part of the Fibres having no reason any longer to prævail over the other, by counter inclination, the Ball instantly ceaseth to touch the plane, and flies off from it, toward that region, to which the Axis and all the circumstant Fibres are then, i. e. after the Evolution, directed. Now, because the Ball is, after this manner, reflected from the plane, with the same inclination, or obliquity, with which it was impinged against it; it is an evident consequence, that the Angle of its Reflexion must be commensurable by the Angle of its Incidence: and that each of them must be so much the more *Obtuse*, by how much less the line of projection doth recede from a perpendicular; and contrariwise, so much the more Acute, by how much more the line of projection doth recede from a perpendicular, or how much neerer it approacheth to a parallel with the plane.

Art. 13. Two *Inferences* from the præmises; *viz.* (1) That the oblique Projection of a Globe against a plane, is composed of a double Parallel: and (2) That Nature suffers no diminution of her right to the shortest way, by Reflexion.

From these Considerations we may infer *Two Observables.* The One, *that the oblique projection of a Globe against a plane, is composed of a double Parallel*, the one with the Perpendicular, the other with the plane: for, the Globe at one and the same time, tends both to the plane, and to that part toward which the plane runs out forward. The Other, *that Nature loseth nothing of her right, by the Reflexion of bodies*; forasmuch as she may nevertheless be allowed still to affect and pursue the shortest, or neerest way: for, because the Angle of Reflexion above the plane, is equal to that Angle, which would have been below the plane, in case the plane had not hinderd the progress of the line of projection beyond it, by reason of the Angles Equal at the Vertex, as Geometricians speak; therefore, is the Reflex way equal to the Direct, and consequently to the shortest, in which the ball projected could have tended from this to that place.

Art. 14. Wherein the *Aptitude* or *Ineptitude* of bodies to *Reflexion* doth consist.

Here, to bring up the rear of this Section, we might advance, a discourse, concerning the *Aptitude* and *Ineptitude* of Bodies to *Reflexion*; but, the dulness of our Pen with long writing, as well as the Confidence we have of our Readers Collective Abilities, inclining us to all possible brevity, we judge it sufficient onely to advertise, that what we have formerly said, concerning the Aptitude and Ineptitude of Bodies to *Projection*, hath anticipated that Disquisition. For, certain it is, in the General, that such Bodies, which are More Compact, Cohærent, and Hard, as they may be, with more vehemence, and to greater distance, *Projected*: so may they, with more vehemence, and to greater distance Rebound, or be *Reflected*; provided, they be impinged against other bodies of

of requiſite Compactneſs, Cohærence, and Hardneſs. And, the Reaſon, why a Tennis-ball doth make a far greater Rebound, than a Globe of Braſs; of the ſame magnitude, and thrown with equal force; is onely this; that there is not a proportion betwixt the Force impreſt by the Projicient; and the Gravity of each of them; or betwixt the Gravity of each, and the Reſiſtence of the Plane. Which holds true alſo concerning other bodies, of different Contextures.

CONCLUSION.

Ingenious Reader,

I Have kept you long at Sea, I confeſs, and (ſuch was the Unskilfulneſs of my Pen, though ſteered, for the moſt part, according to the lines drawn on thoſe excellent Charts of *Epicurus* and *Gaſſendus*) often ſhipwrackt your Patience. But, be pleaſed to conſider, that our way was very Long and tædious; inſomuch as we had no leſs than the whole of that vaſt and deep Ocean of *Sublunary Corporeal Natures*, to ſayl over: that our paſſage was full of Difficulties, as well in reſpect of thoſe ſundry Rocks of Incertitude, which the great Obſcurity of moſt of thoſe Arguments, whoſe diſcovery we attempted, inevitably caſt us upon; as of thoſe frequent Miſts and Foggs, which the exceeding Variety of mens Opinions, concerning them, ſurrounded and almoſt benighted our judgement withal: and chiefly, that if by the voyage your Underſtanding is brought home not only ſafe, but inriched, though in the leaſt meaſure, with that ineſtimable Wealth, the *Knowledge of Truth*, or what is ſo Like to Truth, as to ſatisfie your Curioſity as fully; as I have reaſon to congratulate my ſelf, for the happineſs of my Care and Induſtry, in being your Pilot, ſo muſt you to eſteem the adventure of your Time and Attention compenſated with good Advantage. And, now you are on Land agen, give me leave, at parting, to tell you; That all the *Fare* I ſhall ever demand of you, is only a *Candid ſentiment of my Good-will and cordial Devotion to the Commonwealth of Philoſophy.* Which, indeed, doth ſo ſtrongly Animate me on to enterprizes of Publique Utility, though but to thoſe in the Second Form of Scholars; that I can be well contented, not only to neglect opportunities of Temporal advantages to my ſelf, while I am imployed in the ſtudy, how to contribute to the Intellectual promotions of others; but alſo to ſtand in the number of thoſe Active and Free Spirits, who have, through want of Abilities only, miſcarried in their well intended

Endea-

Endeavours for the benefit of Learning; rather than in the list of those Idle, or Envious ones, who having more of Wit, than of Humanity, and wanting nothing but the Inclination to do Good, have buried their Talents, and left the Republique of Arts and Sciences, to suffer in the want of such means of Advancement, as their Capacities might easily have afforded unto it.

'Tis the Custom of the Multitude, you Know, always to estimate the Counsel of Designs only by their Success; and never allowing for Impediments or sinister Accidents, to account the Goodness of an Undertaking to consist wholly in the Felicity of its Event: but, such is the justice of Wisdom, that it consigns a Reward to a good Intention; and decrees a Lawrel to be planted on his Grave, who fals in the generous Attempt of any noble Discovery, as well as one to be placed on his Head, who shall be so much beholding to the Favour and Assistance of his Fortune, as to Accomplish it. This I put you in mind of, not out of Arrogance, as if I challenged any thing as due to me, besides a lively Resentment of my constant and sincere Zeale to the Encrease of Knowledge; but, to possess you more fully with the Equity of my Expectation, which aims at no other Reward, but what Detraction it self dares not dispute my Right unto, and much less than what, I presume, your own Charity would, if I had referred my self thereunto, have readily assigned me.

But, lest I seem to prevent you in your Inclination, or to Extort that from you by force of Argument, which as well your own innate Candor, as judicious Æquanimity, had sufficiently præpared you to offer me of your own accord; I resigne you to your Peace, and the undisturbed enjoyment of those Pleasures, which usually result from the memory of Difficulties once overcome: Having first assured you, that your benigne Acceptance of my Services, and Pardon of my Misfortunes (so I may call all such Errors, whose præcaution was above the power of my humble judgement) in this Voyage; may prove a chief Encouragement to me, to adventure on a *Second*, without which this

First must be Imperfect; and that is for a Description of the Nature of that Paradise of the World, that bright shadow of the All-illuminating and yet Invisible Light, that Noble Essence, which we know to be within us, but do not understand because it is within us, and cannot understand without it, the *Humane Soul*; and that, so soon as Quiet and Physick shall have repaired those Decays in the Weather-beaten Vessel of my Body, which long Sitting, frequent Watchings, and constant Solicitude of mind have therein made.

In the meantime, I conjure you, by your own Humanity, to remember and testifie, that in this my Conversation with you, you have found me so far from being Magisterial in any of the Opinions I præsented; that considering my own Humor of Indifferency, and constant Dubiosity (frequently professed, but more expresly, in the First Chapter of this Work, and 1. *Art. of the* 1. *Chap.* 3. *Book.*) it hath somewhat of wonder in it, that I ever proposed them to Others: nor, indeed, can any thing solve that wonder, but my Hopes, thereby secretly to undermine that lofty Confidence of yonger Heads, in the Certitude of Positions and Axioms Physiological; and by my declared Scepticism even in such Notions, as my self have laboured to assert, by the firmest Grounds, and strongest Inducements of Belief, to reduce them to the safer level of

Quò magis quærimus, magis dubitamus.

FINIS.